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ANNALS
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Volume 46 SEPTEMBER, 1953 No. 3

A REVIEW OF THE FALSE SPIDER MITE GENUS TENUIPALPUS DONNADIEU (ACARINA: PHYTOPTIPALPIDAE)

NOTICE

All Members of the old Entomological Society of America who have not as yet paid their dues for 1953, or indicated their preference of a Journal, should do so immediately. No further issues of the Annals will be sent to Members in arrears.—Editor.

Genus **Tenuipalpus** Donnadieu

Tenuipalpus Donnadieu, 1875, Recher. Serv. Hist. Tetranych., p. 111; Vitzthum, 1929, Tierw. Mitteleur., 3(7): 49; Zacher, 1932, Zool. Anz., 97(7/8): 182; Geijskes, 1939, Meded. Landbouwh. Wageningen, 42(4): 20; Lawrence, 1940, Jour. Ent. Soc. S. Afr., 3: 114; Sayed, 1942, Bull. Soc. Fouad 1er Ent., 26: 82, 93; Lawrence, 1943, Trans. Roy. Soc. S. Afr., 30(1): 47; Baker, 1945, Proc. Ent. Soc. Washington, 47(2): 33; Sayed, 1946, Bull. Soc. Fouad 1er Ent., 30: 99; McGregor, 1949, Mem. S. Calif. Acad. Sci., 3(2): 4; Sayed, 1950, Proc. Eighth Internatl. Congress Ent., p. 1016; Pritchard and Baker, 1952, Univ. Calif. Publ. Ent., 9(1): 41.

Type of genus.—*Tenuipalpus palmatus* Donnadieu, by subsequent designation of Vitzthum, 1929.

[1]U. S. Department of Agriculture, Agricultural Research Administration, Bureau of Entomology and Plant Quarantine.

[2]University of California, Berkeley.

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EDWARD W. BAKER[1] AND A. EARL PRITCHARD[2]

Mites belonging to the genus *Tenuipalpus* feed on plants. One species, *T. pacificus* Baker, is known to be a serious pest of orchids. *T. granati* Sayed occurs on grapes, pomegranates, and citrus in the Mediterranean region, but this species is not yet considered to be of agricultural significance. Others feed on tropical plants that have been introduced into the southern United States, and some may prove to be of economic importance on ornamentals.

Sixteen species and subspecies names have been proposed that properly belong to the genus *Tenuipalpus*, but no keys have been presented to distinguish them except for the three species occurring in California. Collecting throughout the warmer regions of the world will undoubtedly disclose many undescribed species.

The present paper summarizes our scant knowledge of the genus. A key and a synoptic treatment of the species are presented. Five new species are described. All of the recognized species, except the three described and figured by Pritchard and Baker (1952), are illustrated, because earlier drawings omitted much of the finer details. The single species described by Vitzthum (1920) is not figured because it has not been definitely recognized.

Genus **Tenuipalpus** Donnadieu

Tenuipalpus Donnadieu, 1875, Recher. Serv. Hist. Tetranych., p. 111; Vitzthum, 1929, Tierw. Mitteleur., 3(7): 49; Zacher, 1932, Zool. Anz., 97(7/8): 182; Geijskes, 1939, Meded. Landbouwh. Wageningen, 42(4): 20; Lawrence, 1940, Jour. Ent. Soc. S. Afr., 3: 114; Sayed, 1942, Bull. Soc. Fouad 1er Ent., 26: 82, 93; Lawrence, 1943, Trans. Roy. Soc. S. Afr., 30(1): 47; Baker, 1945, Proc. Ent. Soc. Washington, 47(2): 33; Sayed, 1946, Bull. Soc. Fouad 1er Ent., 30: 99; McGregor, 1949, Mem. S. Calif. Acad. Sci., 3(2): 4; Sayed, 1950, Proc. Eighth Internatl. Congress Ent., p. 1016; Pritchard and Baker, 1952, Univ. Calif. Publ. Ent., 9(1): 41.

Type of genus.—*Tenuipalpus palmatus* Donnadieu, by subsequent designation of Vitzthum, 1929.

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Mites belonging to the genus *Tenuipalpus* may be readily recognized by the broad podosoma and narrow opisthosoma. The palpi are three-segmented; the venter of the rostrum possesses a pair of feathered setae; the anterior end of the stylophore lacks or nearly lacks transverse ribs; the fifth dorsolateral hysterosomal seta is flagelliform, and in one species lacking; one or both pairs of medioventral podosomals may be doubled and the anterior setae displaced to the propodosoma.

Tenuipalpus simplex Vitzthum is not included in the following key, because it is inadequately described, and specimens were not available for study.

KEY TO THE SPECIES (FEMALES)

1. Hysterosoma with seven pairs of lateral setae, the sixth being flagellate..... 2
   Hysterosoma with six pairs of lateral setae, the flagellate seta being absent..... **quadrisetosus**
2. Podosoma with only one pair of posterior medioventrals..... 3
   Podosoma with two pairs of posterior medioventrals..... 16
3. Podosoma with only one pair of anterior medioventrals..... 4
   Podosoma with two pairs of anterior medioventrals..... 11
4. All mediodorsal hysterosomals minute..... 5
   All or some mediodorsal hysterosomals strongly enlarged..... 10
5. Opisthosoma with medioventral and genital setae plumose..... 6
   Opisthosoma with medioventral and genital setae bare..... 7
6. Podosoma with posteromedian ventral setae plumose; caudal pair of anal setae nude or nearly so..... **guamensis**
   Podosoma with posteromedian setae nude; both pairs of anal setae strongly plumose..... **heveae**
7. Hysterosoma with third, fourth, and fifth dorsolaterals shorter than or not much longer than intervals between bases..... 8
   Hysterosoma with third, fourth, and fifth dorsoventrals strong and much longer than intervals between bases..... 9
8. Third dorsal propodosomal and third, fourth, and fifth dorsolateral hysterosomals short, broad, and strongly serrate..... **anoplus**
   Third dorsal propodosomal and third, fourth, and fifth dorsolateral hysterosomals longer, slender, and finely serrate..... **knorri**
9. Third dorsal propodosomal over one-half as long as distance between its base and caudal margin of propodosoma; lateral projection of body just anterior to coxa III broadly subquadrate..... **micheli**
   Third dorsal propodosomal less than one-half as long as distance between its base and caudal margin of propodosoma; lateral projection of body just anterior to coxa III slender, subconical..... **podocarpi**
10. Second pair of dorsal propodosomals and all dorsocentral hysterosomals strongly enlarged..... **dasples**
    Second pair of dorsal propodosomals and third pair of dorsocentral hysterosomals minute; first two pairs of dorsocentral hysterosomals strongly enlarged..... **palmatus**
11. Dorsocentral hysterosomals enlarged..... 12
    Dorsocentral hysterosomals minute, setiform..... **carolinensis**
12. Hysterosoma with dorsocentrals as long as or longer than distance between pairs..... 13
    Hysterosoma with dorsocentrals much shorter than distance between pairs..... **pigrus**
13. Dorsal propodosomals one and two small, setiform, of equal size..... 14
    Dorsal propodosomals one small and setiform, two broadly spatulate but not so large as hysterosomals which are distinctly longer than broad; body with strong striate pattern..... **argus**
14. Body with strong striate pattern..... 15
    Body with only few transverse striae..... **bakeri**
15. Dorsocentral hysterosomals broadly spatulate, about as long as broad; humeral seta blunt at distal end..... **rhysus**
    Dorsocentral hysterosomals narrowly lanceolate, pointed at tip; humeral seta lanceolate..... **rhagicus**

16. Propodosoma with one pair of anterior medioventral setae.....17
    Propodosoma with two pairs of anterior medioventral setae.....**pacificus**
17. Hysterosoma with three pairs of dorsocentrals.....**eriophyoides**
    Hysterosoma with one pair of dorsocentrals.....**granati**

Tenuipalpus quadrisetosus Lawrence

(Plate VI)

Tenuipalpus quadrisetosus Lawrence, 1940, Jour. Ent. Soc. S. Afr., 3: 114 (figs. ventral aspect of nymph and enlargement of gnathosoma); Lawrence, 1943, Trans. Roy. Soc. S. Afr., 30: 37 (fig. dorsum of nymph). Monotype.—Nymph, Stella Bush, Durban, South Africa, on *Cryptocarya woodi;* in the Natal Museum.

Tenuipalpus gibbus Lawrence, 1943, Trans. Roy. Soc. S. Afr., 30: 42 (figs. dorsum of female and dorsum of male). Cotypes.—Three males, seven females, Stella Wood, Durban, South Africa, on *Cryptocarya woodi;* in the Natal Museum. New synonymy.

The palpus, body shape, and rostral shield of the type nymph of *quadrisetosus* indicate that it belongs to the genus *Tenuipalpus sens. str.* Nymphal material of *T. quadrisetosus* that was subsequently described was found in association with adults described as *T. gibbus*, and there is now no doubt that they represent the same species.

T. quadrisetosus departs widely in many respects from other members of the genus *Tenuipalpus*, the most obvious difference being in the lack of the penultimate pair of flagellate dorsolateral hysterosomals. The conspicuous horseshoe-shaped markings of the hysterosoma in the female are also characteristic. Femur IV possesses a seta that is not found in the other species.

There are one pair of anterior medioventral podosomals and one pair of posterior medioventral podosomals. The distal segment of the palpus bears two sensillae in the male, one sensilla in the female. Tarsi I and II in both the male and female each bears a single, slender, curved, sensory rod. There is no lateral lobe of the body immediately anterior to coxa II.

T. quadrisetosus is known only from the type host and type locality.

Tenuipalpus guamensis Baker

(Plate I)

Tenuipalpus guamensis Baker, 1945, Proc. Ent. Soc. Washington, 47: 36 (figs. female venter, male venter, enlargement of palpus). Type.—Female, Sumay, Guam, on *Neottopteris nidus;* in the U. S. National Museum.

Guamensis is distinct from other members of the genus which possess a single pair of anterior and a single pair of posterior medioventral podosomals in that the posteromedian pair are plumose, genu IV possesses a lanceolate seta, and the dorsal striate pattern is practically missing.

T. guamensis is known only from the type series.

Tenuipalpus heveae Baker

(Plate I)

Tenuipalpus heveae Baker, 1945, Proc. Ent. Soc. Washington, 47: 36 (fig. venter of female). Type.—Female, Belterra, Brazil, on rubber leaf; in the U. S. National Museum.

Heveae is distinct from other species belonging to the group possessing a single pair of anterior and a single pair of posterior medioventral podosomals in that the latter pair is nude; neither genu IV nor tibia IV possesses a lateral seta, and the striate pattern of the body is distinct.

T. heveae is known only from the type females.

Tenuipalpus anoplus, new species
(Plate II)

T. anoplus belongs to that group of species having a single pair of anterior medioventral podosomals and a single pair of posterior medioventral podosomals. It differs from all other members of this group by having dorsolateral hysterosomals three, four, and six strongly serrate and shorter than the intervals between their bases.

Female.—Palpus with a single sensory seta terminally. Femora I and II with anterior setae short and setiform, serrate. Femur, genu, and tibia IV each without dorsal or lateral seta. Tarsi I and II each with a very short, clublike sensilla, without the overlying lanceolate seta; tarsal appendages consisting of two claws and an empodium, each a pad bearing two ventral rows of tenent hairs. Rostral shield with a pair of deeply divided median lobes, a pair of strong mediolateral lobes, and a pair of lateral angulations. Propodosoma with a few mediolongitudinally directed striae and a few mediotransverse striae; first and second dorsal propodosomals minute; third dorsal propodosomal very short and lanceolate-serrate. Hysterosoma with a few large striae dorsally; the dorsal pores present; dorsocentrals minute; humeral minute; dorsolaterals six in number, the fifth flagelliform; the others narrowly lanceolate, strongly serrate, and shorter than the intervals between their bases. Podosoma with a long pair of anterior medioventrals and a short pair of setae medioventrally. Opisthosoma with ventral setae all slender, tapering, and apparently nude. Length 273μ; width 176μ.

Male.—Unknown.

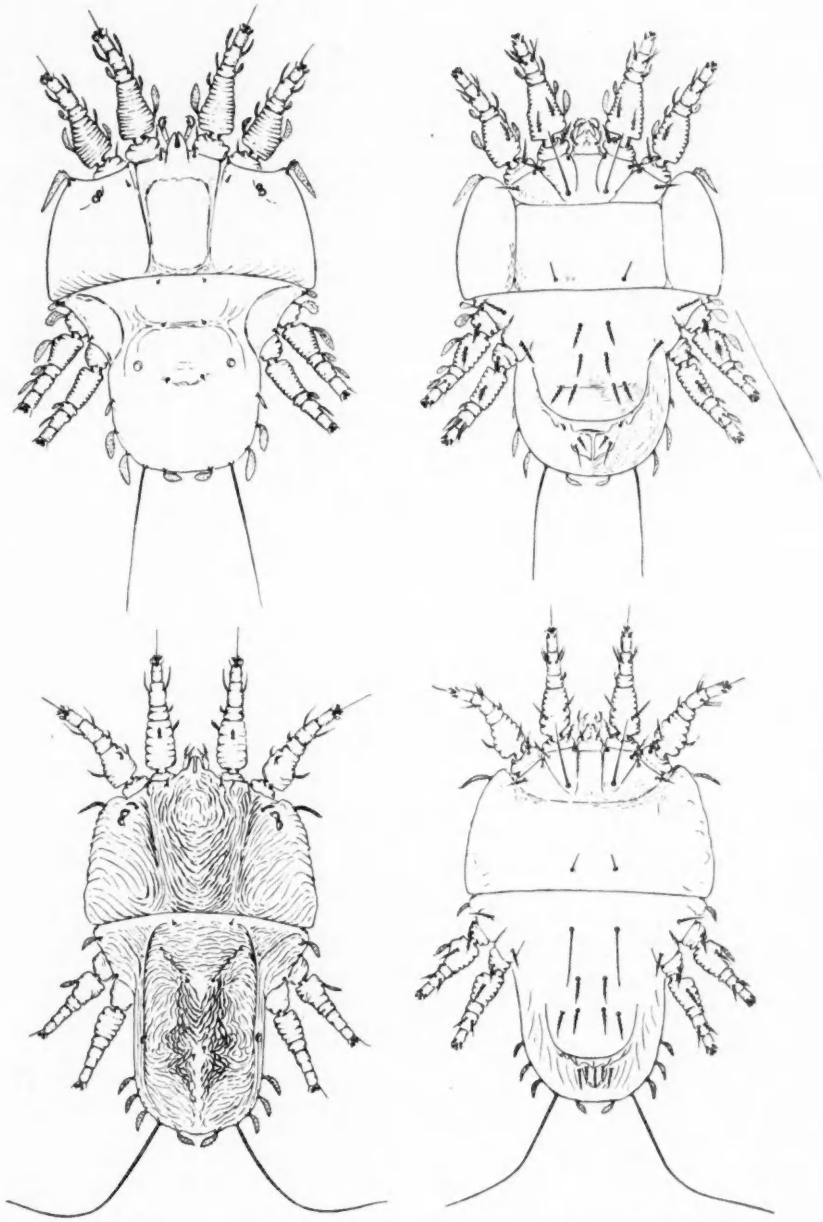
Nymph.—Similar to female.

Holotype. Female, Coconut Grove, Florida, February 15, 1949 (O. D. Link), on mahogany (*Swietenia Mahogani*); in the U. S. National Museum (Type no. 1999). *Paratypes:* 34 females, 5 nymphs (same data as holotype).

Tenuipalpus knorri, new species
(Plate III)

T. knorri belongs to the group possessing a single pair of anterior and a single pair of posterior medioventral podosomal setae. It differs from other members of this group in having very slender dorsolateral hysterosomals and in having a long slender third pair of dorsal propodosomals, as well as having nude ventral setae. The dorsal striate pattern is transverse and light.

Female.—Palpus with a single sensory seta. Femora I and II with setae of medium length, slender, serrate. Femora and genua IV without dorsal or lateral setae. Tarsi I and II each with a short, slender, lanceolate seta and beneath it a rodlike sensilla; tarsal appendages



Tenuipalpus guamensis. Upper left: female, dorsal aspect; upper right: female, ventral aspect.

Tenuipalpus heveae. Lower left: female, dorsal aspect; lower right: female, ventral aspect.

consisting of two padlike claws and empodium bearing two ventral rows of tenent hairs. Rostral shield with a pair of deeply divided median lobes, without mediolateral lobes. Propodosoma with a few transverse striae; first and second dorsal propodosomals minute; third pair long, very slender, and serrate. Hysterosoma with a few large transverse striae dorsally; dorsal pores present; dorsocentrals minute; humeral minute; fourth dorsolateral long, flagelliform, the others about as long as interval between bases, all slightly lanceolate-serrate. Podosoma with a short pair of anterior medioventrals and a long pair of posterior medioventrals. Opisthosoma with ventral setae slender, tapering, and nude. Length 290μ; width 176μ.

Male.—Similar to female. Propodosoma with third dorsal seta larger than others, slightly lanceolate-serrate. Medioventral opisthosomals located anterior to middle of opisthosoma. Length 260μ; width 150μ.

Deutonymph and *protonymph.*—Similar to female except humeral and dorsolateral hysterosomals more broadly lanceolate.

Larva.—Similar to nymphs; dorsolateral hysterosomals very slender, fourth pair, as in nymphs, flagelliform.

Holotype. Female, Concordia, Argentina, February 16, 1951 (L. C. Knorr), on *Salix alba;* in the U. S. National Museum (Type no. 2000). *Paratypes.* Eighteen females, ten males, twenty-one nymphs, and five larvae (same data as holotype).

Nine females, eight males, eight nymphs, and one larva were also examined from Concordia, Argentina, February 19, 1951 (L. C. Knorr), on *Sapium* sp.

This species is named in honor of the collector, L. C. Knorr.

Tenuipalpus micheli Lawrence

(Plate II)

Tenuipalpus micheli Lawrence, 1940, Jour. Ent. Soc. S. Afr., 3: 111 (figs. female venter, dorsum, tarsus I, and gnathosoma); Lawrence, 1943, Trans. Roy. Soc. S. Afr., 30: 35 (figs. dorsum of female opisthosoma and lateral portion of propodosoma, dorsum of nymph). Monotype.—Female, Umhloti Beach, Natal, on *Chaetacme aristata;* in the Natal Museum.

Micheli may be distinguished from other species having a single pair of anterior and a single pair of posterior medioventral podosomals by the possession of a long third pair of dorsal propodosomals which is over one-half as long as propodosoma; by the broadly subquadrate lateral projection of the body just anterior to coxa III; and by the long, lanceolate-serrate dorsolateral hysterosomals.

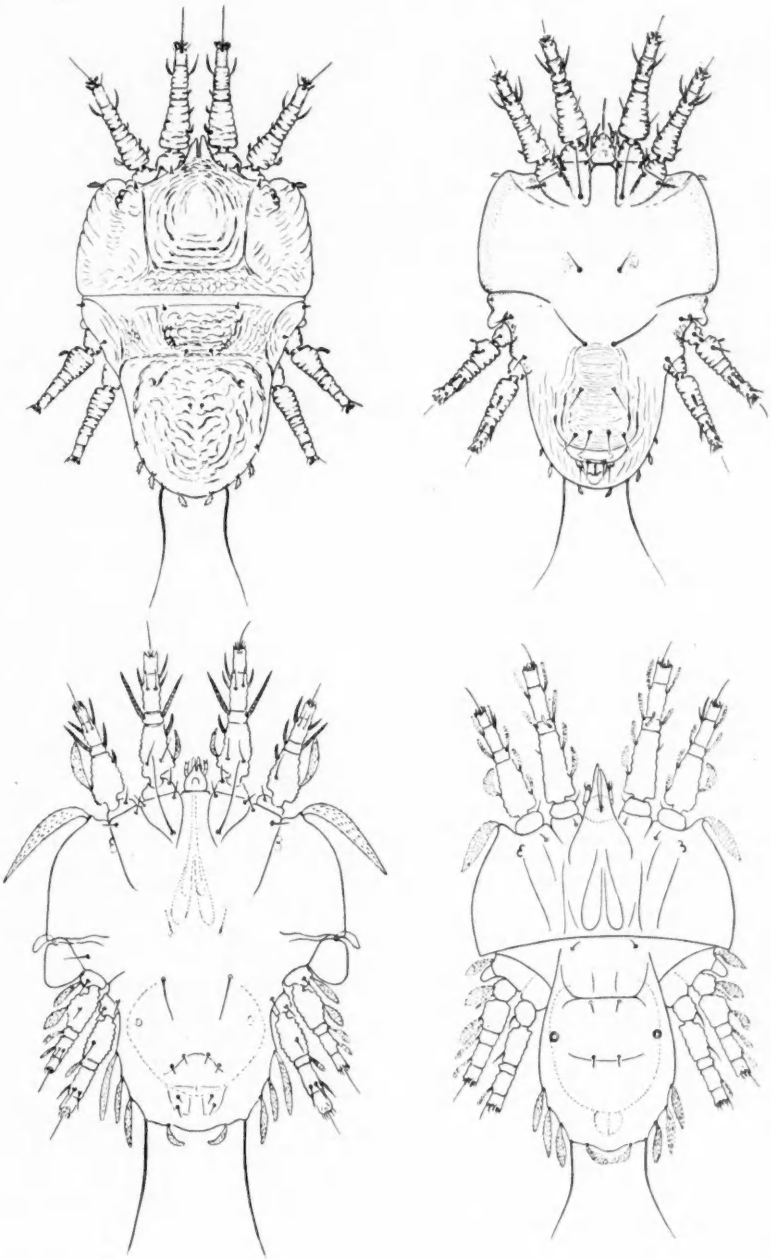
T. micheli is known only from the type host and type locality. No information concerning this species is available other than in the original description from which the above diagnosis was made.

EXPLANATION OF PLATE II

Tenuipalpus anoplus. Upper left: female, dorsal aspect; upper right: female, ventral aspect.

Tenuipalpus micheli. Lower left: female, ventral aspect (after Lawrence).

Tenuipalpus podocarpi. Lower right: female, dorsal aspect (after Lawrence).



Tenuipalpus podocarpi Lawrence

(Plate II)

Tenuipalpus podocarpi Lawrence, 1943, Trans. Roy. Soc. S. Afr., 30: 40 (fig. dorsum of female). Cotypes.—Males, females, and nymphs, Cathkin Peak, Drakensberg Mts., South Africa, on *Podocarpus falcata;* in the Natal Museum.

Podocarpi may be distinguished from its related species which possess only a single pair of anterior and a single pair of posterior medioventral podosomals by having the third pair of dorsal propodosomals not one-half as long as the propodosoma; by the slender, subconical body projection just anterior to coxa III; and by the possession of large, lanceolate-serrate dorsolateral hysterosomals as in ***micheli***.

T. podocarpi is known only from the type host and type locality. No information other than that of the original description is available for this species.

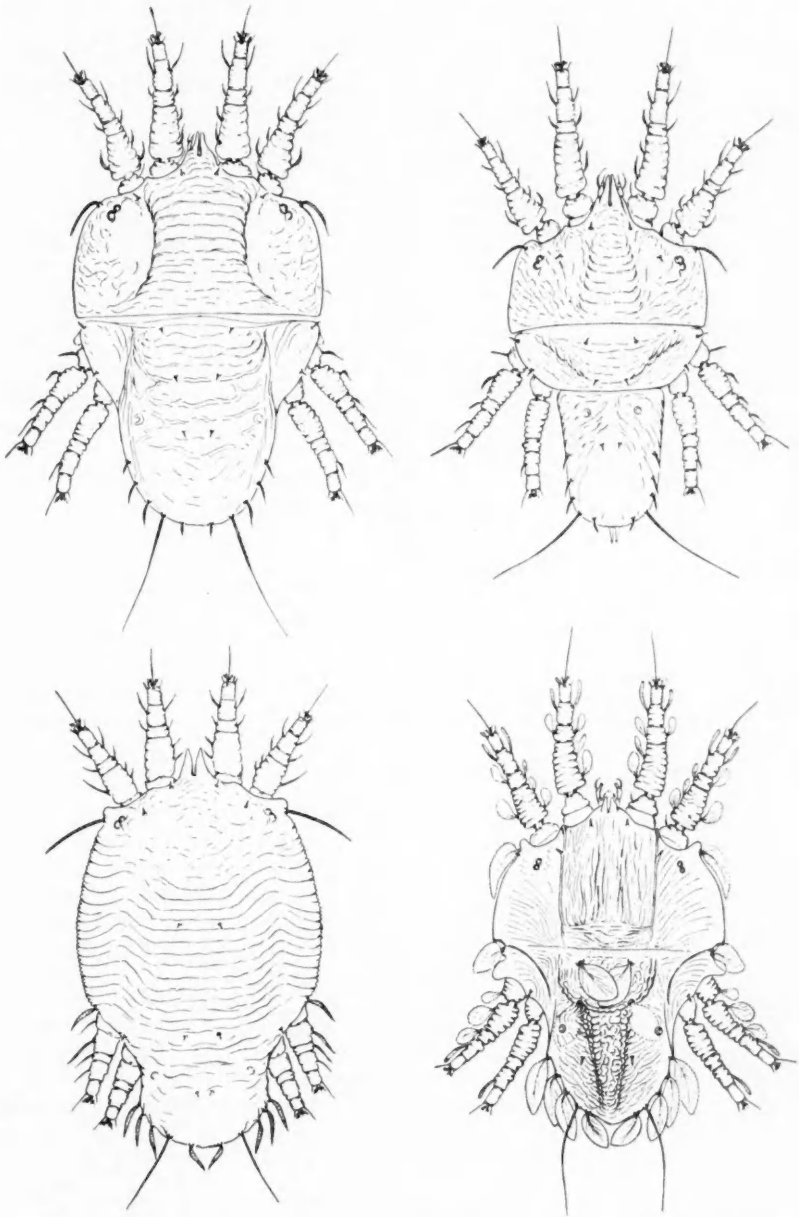
Tenuipalpus dasples, new species

(Plate IV)

Dasples differs from other members of the genus *Tenuipalpus* that possess a single pair of anterior and a single pair of posterior medioventral podosomals by having the second dorsal propodosomal and all the mediodorsal hysterosomals very strongly enlarged.

Female.—Palpus wrinkled with a single sensory seta on third segment. Femora I and II with anteroproximal seta strongly enlarged, the anterodistal seta somewhat enlarged; tarsi I and II each with a short broadly lanceolate seta posterodistally and beneath this a short slender rod-like sensory seta; claws and empodium each consisting of a slender pad bearing two rows of ventral tenent hairs. Rostral shield with long, befurcate, median projection, a secondary mediolateral lobe on each side, and lateral angulation. Propodosomal dorsum with a few longitudinal striae mediolaterally and strong transverse striae medially; first dorsal propodosomal short and slightly lanceolate; second dorsal propodosomal very long and long-spatulate; third dorsal propodosomal somewhat shorter than second, strongly widened proximally and acuminate distally. Hysterosoma with a few striae dorsolaterally and parallel to body margin; medially striae strong, raised, a transverse to irregular pattern; hysterosomal pores present, mediodorsal hysterosomals large and spatulate, the first pair about as long as interval between their bases; humeral seta large, broad proximally, tapering, and broadly rounded distally; dorsolaterals six in number, the first a tiny, lanceolate seta, the second a small, spatulate seta, the third and fourth, very large, broad proximally and acuminate distally, the fifth a flagelliform seta, the sixth a very large broadly spatulate seta. Podosoma with a single pair of very short anterior medioventral setae and with a single pair of longer posterior medioventral setae. Opisthosoma with ventral setae slender and bare; caudolateral areas with a sclerotized series of wrinkles internally, and a series of U-shaped, internal folds anterior to anus and connected with ovipositor. Length of body 333μ; width 220μ.

Male.—Similar to female. Palpus also with a single sensillum on distal segment. Femora I and II with anteroproximal setae setiform and



Tenuipalpus knorri. Upper left: female, dorsal aspect; upper right: male, dorsal aspect; lower left: deutonymph, dorsal aspect.
Tenuipalpus. palmatus. Lower right: female, dorsal aspect (from Berlese collection).

serrate; tarsi I and II without lanceolate setae as in female. Propodosoma with third dorsal seta as long as second. Hysterosoma with mediodorsals much smaller than in female, the second dorsolateral larger and spatulate, the third, fourth, and fifth dorsolaterals smaller and spatulate. Medioventral opisthosomals located anterior to middle of opisthosoma. Length of body 290μ; width 163μ.

Deutonymph.—Similar to female; however, the second dorsal propodosomal much smaller.

Holotype. Female, Oviedo, Florida, April 19, 1950 (O. D. Link), on scrub palmetto (*Sabal Megacarpa*); in the U. S. National Museum (Type no. 2001). *Paratype.* One male, eight females, five nymphs (same data as holotype).

Specimens from cabbage palmetto (*Sabal Palmetto*), East Palatka, Florida, February 27, 1950 (O. D. Link) are very similar to this species, differing in having a much weaker reticulate pattern and in having slender setae on the tibia. However, all are molting from the deutonymph to adult or teneral, and until mature specimens can be studied the status of these will have to be left in some doubt.

Tenuipalpus palmatus Donnadieu

(Plate III)

Tenuipalpus palmatus Donnadieu, 1875, Rech. Serv. Hist. Tetranych., p. 112 (fig. egg, larva, protonymph, deutonymph, male and female); Berlese, 1887, Acari Myriopoda Scorpiones Prostigmata, Fasc. XXXIV, No. 4; Canestrini, 1889, Atti Reale Istit. Veneto (ser. 6), 7: 520; Vitzthum, 1939, Tierw. Mitteleur., 3(7): 49 (fig. female dorsum); Baker, 1945, Proc. Ent. Soc. Washington, 47: 34 (fig. dorsum of female from Berlese); McGregor, 1949, Mem. S. Calif. Acad. Sci., 3(2): 5 (fig. dorsum of female). Types.—Females, France on laurestinus (*Viburnum tinus*); probably lost.

Caligonus calyx Canestrini and Fanzago, 1876, Acad. Sci. Veneto Trentino Ist. Atti., 5: 134; Canestrini and Fanzago, 1878, Atti Reale Istit. Veneto (ser. 4), 5: 156. Types.—Females, Trevigiano, Italy, on "leaves"; probably lost.

T. palmatus was originally described by Donnadieu from *Viburnum* in Europe. Vitzthum (1929) recorded this species from laurel, apple, and citrus in Europe. Baker (1945) figured European material that had been determined by Berlese. The illustrations of all three authors are similar, and Berlese's identification of *T. palmatus* is accepted.

The descriptions by Canestrini and Fanzago of *Caligonus calyx* agree with *Tenuipalpus palmatus*, and Canestrini (1889) considered *C. calyx* to be a synonym of this species. This synonymy is accepted.

Palmatus is distinguished from the related species which possess a single pair of anterior and a single pair of posterior medioventral podosomals by the longitudinal dorsal striae on the propodosma, and more or less typically transverse striae on the hysterosoma; especially by having the posterior dorsocentral hysterosomals minute and equal in size to the first and second dorsal propodosomals. The second pair of

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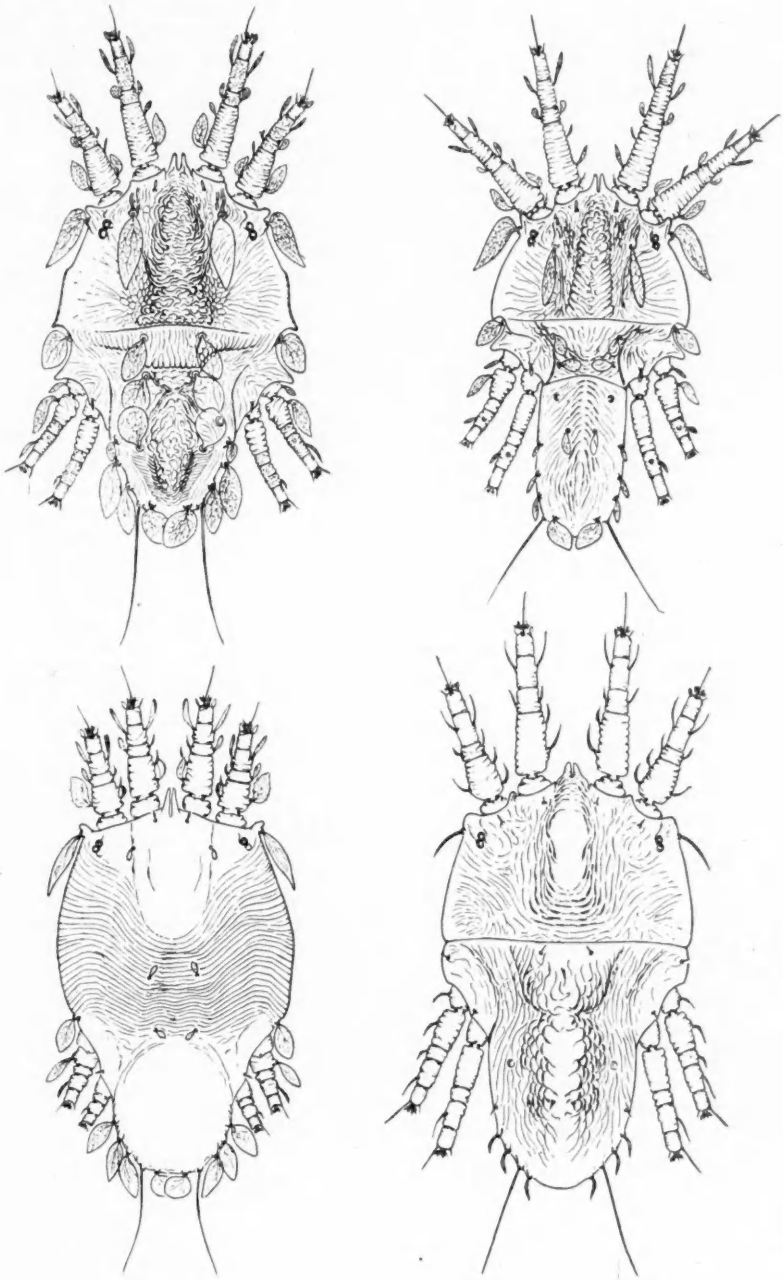
EXPLANATION OF PLATE IV

Tenuipalpus dasples. Upper left: female, dorsal aspect; upper right: male, dorsal aspect; lower left: deutonymph, dorsal aspect.

Tenuipalpus carolinensis. Lower right: female, dorsal aspect.



dorsocentral hysterosomals have been lost in mounting but the setal bases are as large as those of the first pair, indicating setae of that size. The male is similar to the female except in having the dorsocentral hysterosomals all small.

Tenuipalpus carolinensis Baker

(Plate IV)

Tenuipalpus carolinensis Baker, 1945, Proc. Ent. Soc. Washington, **47**: 35 (figs. venter of female and enlargement of tarsal appendages). Type.—Female, Batesburg, South Carolina, on goldenrod; in the U. S. National Museum.

T. carolinensis is distinguished from related species that have two pairs of anterior medioventral podosomals and one pair of posterior medioventral podosomals by having the dorsocentral hysterosomals minute and setiform.

T. carolinensis is known only from the type female.

Tenuipalpus pigrus Pritchard and Baker

Tenuipalpus pigrus Pritchard and Baker, 1952, Univ. Calif. Press. Publ. Ent., 9(1): 43 (figs. female dorsum and venter, male and nymph dorsum). Holotype.—Female, Mt. Diablo, California, on *Umbellularia californica;* in the U. S. National Museum.

Pigrus differs from other species of the genus *Tenuipalpus* that possess two pairs of anterior medioventral podosomals and one posterior pair by having the dorsocentral hysterosomals spatulate and much shorter than the distance between each pair.

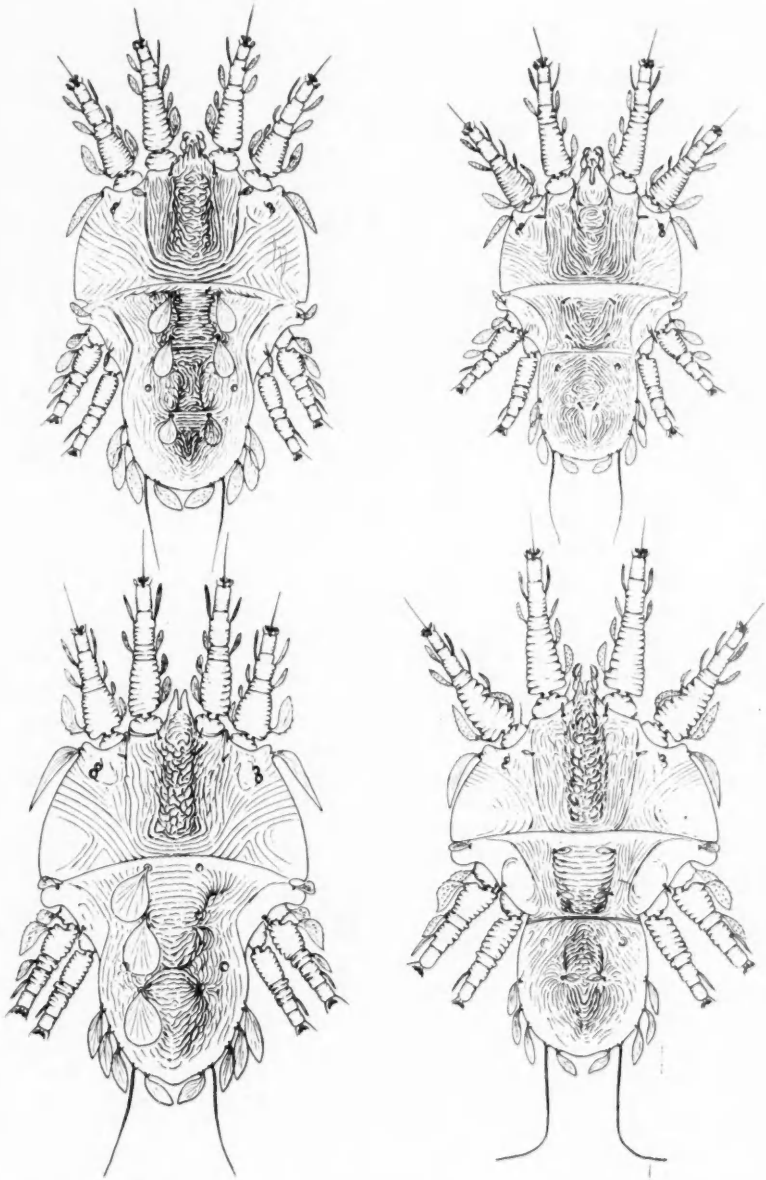
T. pigrus is known only from leaves of the California laurel tree.

Tenuipalpus argus, new species

(Plate V)

Argus belongs to the group of *Tenuipalpus* having two pairs of anterior and only one pair of posterior medioventral podosomals, and is differentiated by the strong dorsal striate pattern, broad, spatulate-lanceolate dorsocentral hysterosomals, and dorsolateral hysterosomals two, three, four, and six enlarged, and lanceolate; dorsal propodosomal one is tiny lanceolate, but two is broadly spatulate, and three is large, lanceolate-serrate but not one-half as long as propodosoma; the humeral seta is lanceolate and *not* blunt at tip.

Female.—Palpus strongly swollen, with a sensory rod and a tiny peg on the distal segment. Femora I and II with setae strongly enlarged, lanceolate-serrate; tarsi I and II each with a short, broadly lanceolate seta posterodistally and beneath this rodlike sense seta; claws and empodium padlike, with the usual two rows of ventral tenent hairs. Rostral shield bifurcate, with two secondary mediolateral lobes on each side, and lateral angulation. Propodosomal dorsum with a few longitudunal striae mediolaterally and strong transverse striae medially; first dorsal propodosomal short and lanceolate; second dorsal propodosomal of about same length but broadly spatulate; third dorsal propodosomal lanceolate, serrate, not half as long as length of propodosoma. Hysterosoma with a few striae dorsolaterally and parallel to body margin; medially with strong transverse striae; pores present; humeral



Tenuipalpus argus. Upper left: female, dorsal aspect; upper right: male, dorsal aspect.

Tenuipalpus rhysus. Lower left: female, dorsal aspect; lower right; male, dorsal aspect.

seta lanceolate-serrate, not blunt at tip as in ***bakeri***; first dorsolateral hysterosomal smaller than humeral, lanceolate; second, third, fourth and sixth dorsolaterals enlarged, lanceolate-serrate; fifth flagelliform; dorsocentral hysterosomals broadly spatulate, broadly rounded, the first two pairs of about equal size and about as long as distance between their bases; the posterior pair similar but smaller. Podosoma with two pairs of anterior medioventral setae, the inner pair the shorter; and a single pair of posterior medioventral setae. Opisthosoma with ventral setae bare. Length 360μ; width 240μ.

Male.—Similar to female in all details except for having small lanceolate dorsocentral hysterosomals and a similar second pair of dorsal propodosomals. Medioventral opisthosomals located at anterior end of opisthosoma. Length 283μ; width 176μ.

Nymph.—Similar to female, except second dorsal propodosomal not expanded.

Holotype. Female, Pomona Park, Florida, February 1, 1950 (O. D. Link), on Yucca; in the U. S. National Museum (Type no. 2002). *Paratypes.* Eleven females, four males, and four nymphs (same data as holotype).

Seven females from Spanish bayonet (*Yucca gloriosa*), Tuscaville, Florida, November 25, 1924 (G. B. Merrill) are also included here.

Tenuipalpus bakeri McGregor

(Plate VI)

Tenuipalpus micheli, Baker, 1945 (not *Tenuipalpus micheli* Lawrence, 1940) Proc. Ent. Soc. Washington, 47: 35. Misidentification.

Tenuipalpus bakeri McGregor, 1949, Mem. S. Calif. Acad. Sci., 3(2): 7 (fig. female dorsum). *Lectotype.*—By present designation, female, Cocoa Beach, Florida, on oak; in the U. S. National Museum.

T. bakeri belongs to those mites having two pairs of medioventral podosomals anteriorly and one pair posteriorly. It can be differentiated from the related species by having the dorsal striate pattern almost lacking in both male and female.

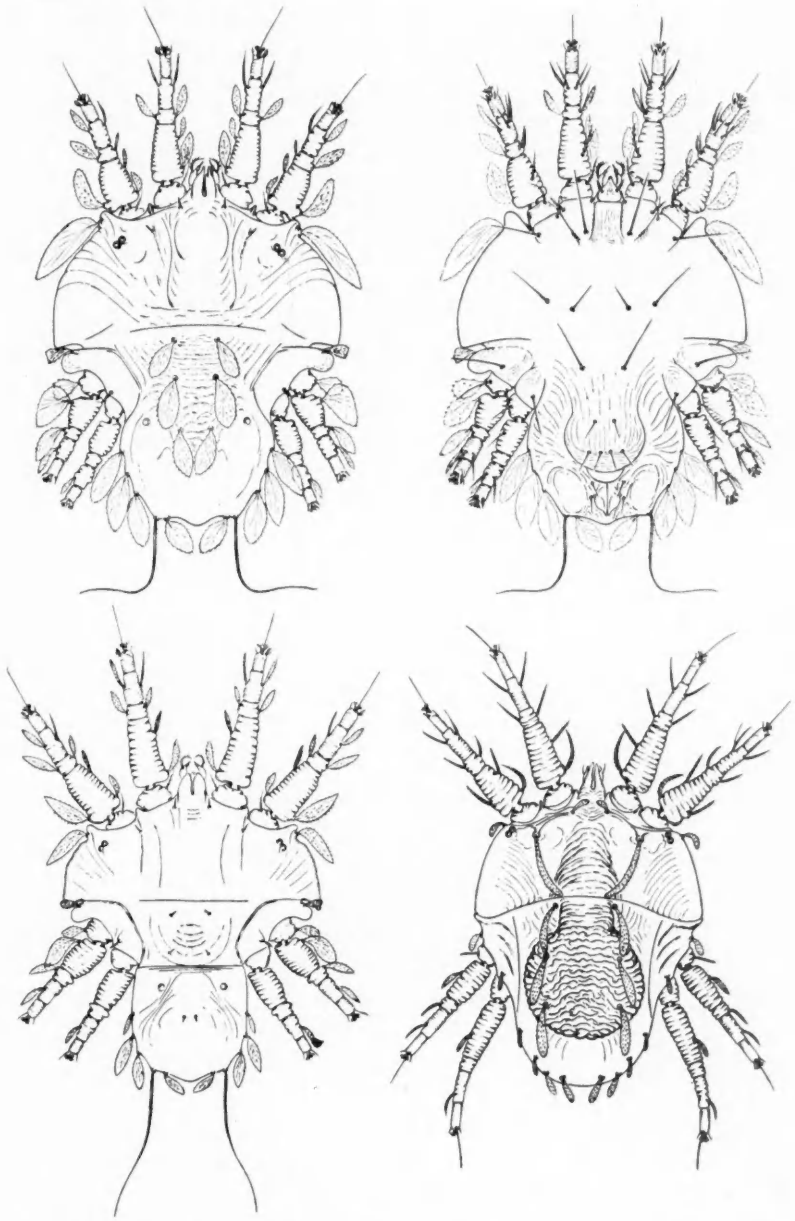
T. bakeri is known from Florida, on oak, and *Icacorea paniculata* Hypaluxo Island, Florida, May 19, 1949 (O. D. Link). Those from Spanish bayonet, *Sobralia*, and magnolia which were formerly listed as this species are new species that are described in this paper.

Tenuipalpus rhysus, new species

(Plate V)

Rhysus belongs to those species possessing two pairs of medioventral podosomals anteriorly and one pair posteriorly, and is characterized by having a strong dorsal striate pattern; by having the first two pairs of dorsal propodosomals small, lanceolate and of equal size, and the third about one-half as long as the propodosoma; by having the humerals blunt, and the dorsocentral hysterosomals very broad and rounded and faintly serrate.

The relationship of this species with *argus*, *bakeri*, and *rhagicus* is close. The differences, although small, are, in the limited number of specimens, constant and without doubt indicate that we are dealing with true species and not variations.



Tenuipalpus bakeri. Upper left: female, dorsal aspect; upper right: female, ventral aspect; lower left: male, dorsal aspect.
Tenuipalpus quadrisetosus. Lower right: female, dorsal aspect.

Female.—Palpus only slightly swollen, with a sensory seta and a tiny peg on the distal segment. Femora I and II with enlarged, lanceolate-serrate setae, especially the outer proximal seta on femur II; tarsi I and II each with a short, broadly lanceolate seta posterodistally and beneath this a short, rodlike sense setae; tarsal claws and pulvillus consisting of pads with the usual double row of ventral tenent hairs. Rostral shield very long, bifurcate, without noticeable secondary lobes and with lateral angulations. Propodosomal dorsum with a few longitudinal striae mediolaterally and strong transverse pattern dorsally; first and second dorsal propodosomals short, lanceolate; third large, lanceolate, lightly serrate, about half as long as propodosoma. Hysterosoma with a few striae dorsolaterally and parallel to body margin; medially striae stronger, transverse; pores present; mediodorsal hysterosomals very large and spatulate, each about as long as interval between their bases; humeral seta much smaller, broadly spatulate and blunt distally; the first dorsolateral short, lanceolate; dorsolaterals two, three, four, and six large, lanceolate, slightly serrate; five flagelliform. Ventrally with two pairs of nude medioventral podosomals anteriorly and one pair posteriorly; other ventral opisthosomal setae nude. Length 333μ; width 256μ.

Male.—Similar to female. Dorsocentrals much smaller, but definitely broadened and lanceolate (much more so than in the related species). Medioventral opisthosomals located at anterior end of opisthosoma. Length 273μ; width 200μ.

Nymph.—Similar to female except the dorsocentral hysterosomals much smaller, as in male.

Holotype. Female, Glen St. Mary, Florida, December 31, 1951 (G. G. Norman), on *Cyrilla racemiflora:* in the U. S. National Museum (Type no. 2003). *Paratypes.* Twenty-five females, fifteen males, thirty-six nymphs (same data as holotype).

Other specimens examined were three females, Vera Cruz, Mexico (at U. S. A. port) on camellia leaf, January 23 1950 (D. J. Smith); one female, Guatemala (at U. S. A. port) on *Sobralia macrantha*, October 12, 1943 (collector unknown); four females and three nymphs, Jacksonville, Florida, on magnolia, April 24, 1924 (Robertson and Williams.) The last two series (on *Sobralia* and magnolia) were previously identified by McGregor (1949) as *T. bakeri* McG.

Tenuipalpus rhagicus Pritchard and Baker

Tenuipalpus rhagicus Pritchard and Baker, 1952, Univ. Calif. Press Publ. Ent., 9(1): 1-94 (figs. dorsum and venter of female, dorsum and venter of male). Holotype.—Female, Crescent Lake, California, on *Vaccinium ovatum;* in the U. S. National Museum.

Rhagicus differs from other species of *Tenuipalpus* that possess two pairs of anterior medioventral podosomals and one posterior pair by having long, lanceolate mediodorsal hysterosomals.

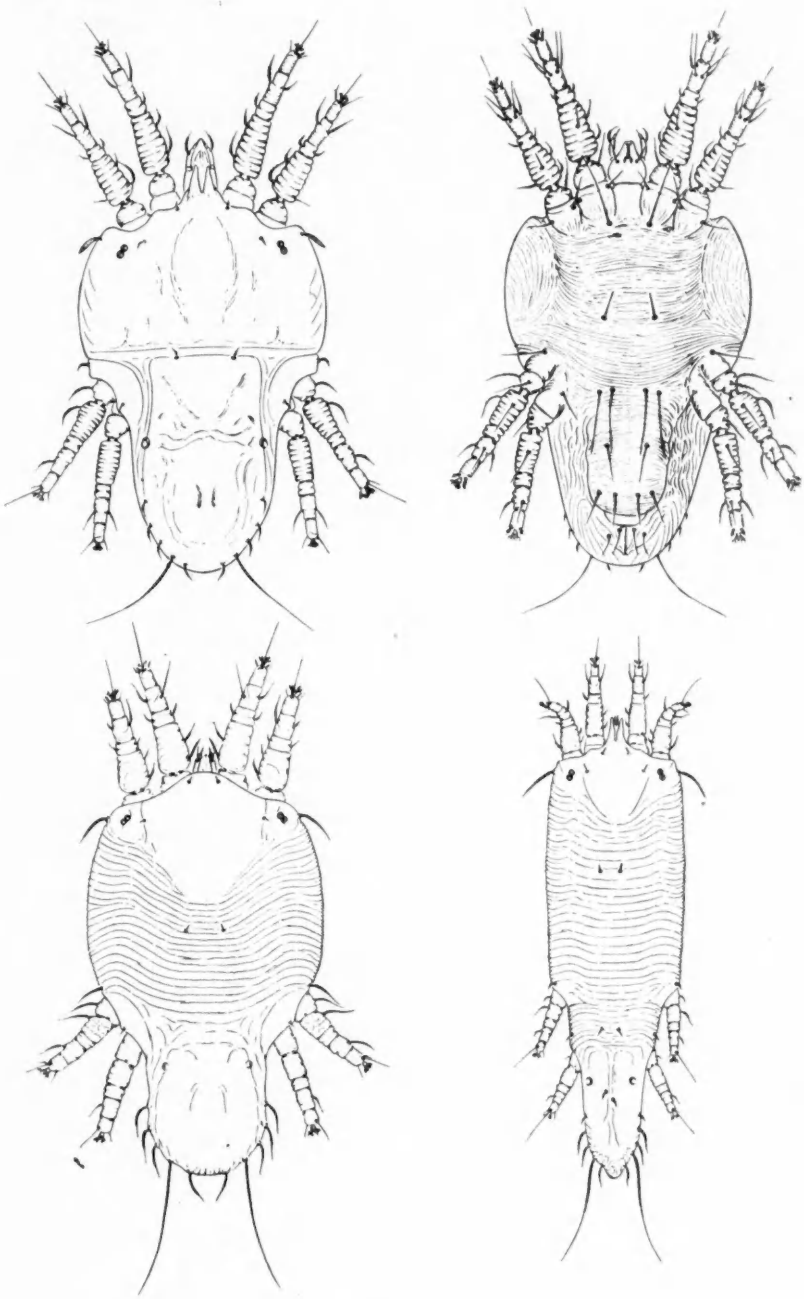
EXPLANATION OF PLATE VII

Tenuipalpus granati. Upper left: female, dorsal aspect; upper right: female, ventral aspect· lower left: nymph, dorsal aspect.

Tenuipalpus eriophyoides. Lower right: nymph, dorsal aspect.

The Mite Genus Tenuipalpus
Baker and Pritchard

PLATE VII



This species is known only from blueberry in California and Oregon, U. S. A.

Tenuipalpus simplex Vitzthum, new status

Tenuipalpus palmatus var. *simplex* Vitzthum, 1920, Arch. Naturg., 84A(6): 8 (1919); Vitzthum, 1929, Tierw. Mitteleur., 3(7): 49. Type.—Female, Weimar, Germany, on apple; possibly in the Vitzthum Collection which we understand was destroyed during World War II.

Simplex was originally described as a variety of *T. palmatus* Berlese on the basis of the enlarged lateral setae of the body and legs not being as long nor strongly widened as in *palmatus*. This description, the Mediterranean distribution, and the host together indicate that *simplex* is possibly an earlier name for the species here referred to as *T. granati* Sayed. However, the type or topotype material should be examined before the synonymy is made.

Tenuipalpus granati Sayed

(Plate VII)

Tenuipalpus orchidarum Sayed, 1942 (not *Acarus orchidarum* Parfitt, 1939), Bull. Soc. Fouad 1er Ent., 26: 96 (figs. female dorsum and venter, male venter, rostral shield, stylophore, gnathosoma, tarsal appendages and venter of female opisthosoma). Misidentification.

Tenuipalpus granati Sayed, 1946, Bull. Soc. Fouad 1er Ent., 30: 100 (figs. ventral aspects of female and male). Cotypes.—Females and males, Lower and Upper Egypt, in vineyards and on pomegranates; probably in M. T. Sayed's collection.

Granati differs from all other species of *Tenuipalpus* that have been described in detail, except *T. eriophyoides*, by having one pair of anterior medioventral podosomals and two pairs of posterior medioventrals. The posterior two pairs of dorsocentral hysterosomals cannot be found in the female, males, nymphs, or larvae examined; the deutonymph does not possess a rostral shield; the posterior group of dorsolateral hysterosomals (other than the whiplike pair) are equal in size.

Tenuipalpus eriophyoides Baker

(Plate VII)

Tenuipalpus eriophyoides Baker, 1948, Proc. Ent. Soc. Washington, 50: 59 (figs. dorsum and venter of nymph). Type.—Nymph, Margil, Basra, Iraq, on unknown host; in the U. S. National Museum.

T. eriophyoides (known only from a deutonymph) agrees with *T. granati* in that there is only one pair of anterior medioventral podosomals and two pairs of posterior medioventral podosomals. The nymph is characterized by its elongate shape, by having a rostral shield, by possessing all dorsocentral hysterosomals, and by having the dorsolateral hysterosomals varying in size.

Tenuipalpus pacificus Baker

Tenuipalpus orchidarum Geijskes, 1939 (not *Acarus orchidarum* Parfitt, 1859), Meded. Landbouwh. Wageningen, 42(4): 4 (figs. dorsum and venter of male and female, and details of rostrum). Misidentification.

Tenuipalpus pacificus Baker, 1945, Proc. Ent. Soc. Washington, 47: 38 (figs. venter

of female and male, and enlargement of female palpus); Pritchard and Baker, 1952, Univ. Calif. Press Publ. Ent., 9(1): 1–94 (fig. female dorsum and venter; male dorsum and venter). Type.—Female, Canal Zone (at U.S.A. port), on *Phalaenopsis stuartiana;* in the U. S. National Museum.

Pacificus may be differentiated from all other members of the genus *Tenuipalpus* by possessing two pairs of anterior medioventral and two pairs of posterior medioventral podosomals.

Baker listed certain orchid hosts in the Panama Canal Zone, Australia, Siam, and the Philippines.

Pritchard and Baker indicated why they believed *Acarus orchidarum* Parfitt to be another species, and they presented records for a number of other orchid hosts in California and Florida, U. S. A.

A list of the species that have been erroneously assigned to the genus *Tenuipalpus* is appended. The proper generic placement of these names may be found in the articles by Baker (1949), Pritchard and Baker (1952), and Baker and Pritchard (1952, 1953).

australis Tucker, 1926 (*Brevipalpus*)
bioculatus McGregor, 1914 (*Brevipalpus*)
cactorum Oudemans, 1929 (*Brevipalpus*)
californicus Banks, 1904 (*Brevipalpus*)
cardinalis Banks, 1912 (*Brevipalpus*)
coronatus (Canestrini and Fanzago) Canestrini, 1889 (*Pentamerismus*)
cuneatus Canestrini and Fanzago, 1876 (*Brevipalpus*)
erytheus Ewing, 1917 (*Pentamerismus*)
geisenheyneri Rübsaamen, 1910 (*Brevipalpus*)
glaber Donnadieu, 1875 (*Brevipalpus*)
grewiae (Rübsaamen) Oudemans, 1938 (*Brevipalpus*)
haumani Lahille, 1927 (*Pseudoleptus*)
inornatus Banks, 1912 (*Brevipalpus*)
lineola (Canestrini and Fanzago) Canestrini, 1889 (*Brevipalpus*)
natalensis Lawrence, 1943 (*Brevipalpus*)
obovatus Donnadieu, 1875 (*Brevipalpus*)
orchidarum (Parfitt) Geijskes, 1939 (*Brevipalpus*)
ornatus Tucker, 1926 (*Tuckerella*, Tuckerellidae)
oudemansi Geijskes, 1939 (*Brevipalpus*)
pseudocuneatus Blanchard, 1940 (*Brevipalpus*)
phoenicis Geijskes, 1939 (*Brevipalpus*)
pulcher (Canestrini and Fanzago) Canestrini, 1889 (*Brevipalpus*)
russulus (Boisduval) Cooreman, 1947 (*Brevipalpus*)
spinosus Donnadieu, 1875 (*Brevipalpus*)
taxi Haller, 1877 (*Pentamerismus*)

ACKNOWLEDGMENTS

We are very grateful to R. F. Lawrence of the Natal Museum, Pietermaritzburg, South Africa, for the loan of specimens of *Tenuipalpus quadrisetosus* and *T. gibbus* for study; to M. T. Sayed of the Ibrahim University, Orman-Giza, Egypt, for making available specimens of *T. granati:* to O. D. Link of the Florida State Plant Board for collecting three new species; to G. G. Norman of the Florida State Plant Board for collecting a new species; to D. J. Smith of the Bureau of Entomology and Plant Quarantine for collecting specimens of a new species at the Brownsville Quarantine Station and to L. C. Knorr of the university of Florida who collected the new species from Argentina and who has materially aided in this and other studies on the Phytoptipalpidae.

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Baker, Edward W., and **A. Earl Pritchard.** 1952. The *Geisenheyneri* species group of the genus *Brevipalpus* (Acarina: Phytoptipalpidae). Ann. Mag. Nat. Hist. (ser. 12), 5: 609–613.

1953. A key to mites of the genus *Pentamerismus*, with descriptions of three new species (Acarina: Phytoptipalpidae). Wasmann Jour. Biol.

McGregor, E. A. 1949. Nearctic mites of the family Pseudoleptidae. Mem. S. Calif. Acad. Sci., 3(2): 1–45.

Pritchard, A. Earl, and **Edward W. Baker.** 1952. The false spider mites of California. Univ. Calif. Pub. Ent., 9(1): 1–94.

PLANT DISEASES IN ORCHARD, NURSERY AND GARDEN CROPS, by ERNST GRAM and ANNA WEBER. Translated from the Danish by EVELYN RAMSDEN. Pp. 618, 10 color plates plus 349 figures. Philosophical Library, Inc., New York. 1953. Price $18.50.

Although many books on plant diseases have appeared during the past half-century, it seems safe to predict that this English translation of Gram and Weber from the original Danish will surpass all others in practical usefulness to the entomologist. Because it has been prepared from the point of view of the grower and the field man it has the practical approach of identification or diagnosis and the recommendation of control or corrective measures. The scope of the book is strictly horticultural, covering diseases of tree and bush fruits (Chapter 2), diseases of vegetables and herbaceous fruits (Chapter 3) and diseases of ornamental plants and trees (Chapter 4). In each of these categories the arrangement is by crops, alphabetically. The first chapter is devoted to an excellent review of the various causes of plant diseases. Non-parasitic agents, too often inadequately covered in the general texts and reference books on plant diseases, are given thorough coverage. Similarly, the fifth and last chapter deals with a review of control measures.

Although basically the diseases covered are those known in Denmark, the editor (Dr. R. W. G. Dennis) has added accounts of most of those of horticultural crops in Britain but not included in the original Danish text. The result is that most of the important diseases of horticultural crops in North America are also included. The coverage under each individual crop is extensive. Thus, under apple, for instance, over 100 diseases are included; under potato an equally large number of diseases is discussed. Each disease is treated in proportion to its importance and the available information, to include causal organism if any, diagnostic features, control or corrective measures, and general pertinent information.

An especially useful feature of the book are the keys to the diseases of each crop having enough to warrant such treatment. The numerous illustrations also contribute very materially to the usefulness of the book. They are well chosen and, with few exceptions, they show what they were intended to show. The style used throughout is one of a happy medium between "popular" and "academic." The information is clearly and concisely given; there is neither excess verbiage nor purely superficial treatment. References to the literature (bibliography at end of each chapter) are freely given for those who wish to read further on any particular subject. The only fault that seems of sufficient importance to mention is the lack of reference to the newer fungicides. In this connection it must be remembered that the first Danish edition did not appear until 1940 and the second edition in 1944.

The book should prove very valuable to all who are concerned with the diagnosis and prevention of diseases of horticultural crops.—G. W. FISCHER.

THE MALE GENITALIA OF THE STRATIOMYIDAE WITH SPECIAL REFERENCE TO WISCONSIN SPECIES

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An examination of the genitalia of insects is often necessary for species identification. Studies of these parts also may strengthen an understanding of interrelationships that are based primarily on characters other than genitalia. Past workers have studied the genitalia of the Stratiomyidae very little, probably because of their relatively minute sizes. In these studies the males of a representative species from each genus, usually the genotype, have been dissected, the parts cleared and drawings made. The male genitalia were prepared for study by relaxing pinned specimens, pulling out the terminal parts and placing them in a ten percent solution of sodium hydroxide for one or two days, depending upon their darkened condition. They were then washed in water and placed in glycerine in capsules so that they could be attached by their corks to pins with the original specimens. Studies and drawings were made by placing the specimens in white porcelain spot dishes which contained a smear of petroleum jelly in the bottom, and then adding enough glycerine to cover the genitalia. The camera lucida was used as an aid in making the sketches.

DISCUSSION OF THE STRATIOMYID MALE GENITALIA

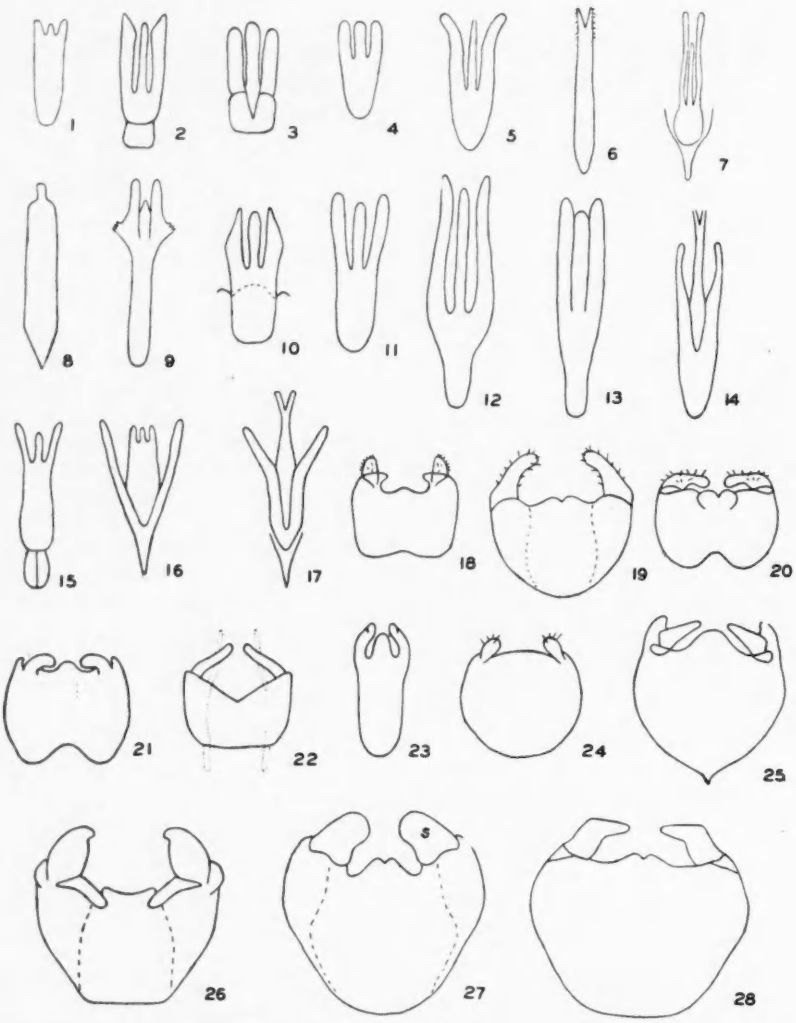
This discussion attempts to point out the distinguishing features of the genitalia of each representative species dissected. Wherever it seems feasible similarities among genitalia are mentioned which might strengthen theories of relationships among the genera of the Stratiomyidae.

The genera, *Merosargus*, *Microchrysa*, *Sargus*, *Ptecticus* and *Cephalochrysa* which belong to the subfamily Geosarginae, were collected in Wisconsin.

Merosargus caerulifrons Johnson was not included in this study because only females were available for dissection.

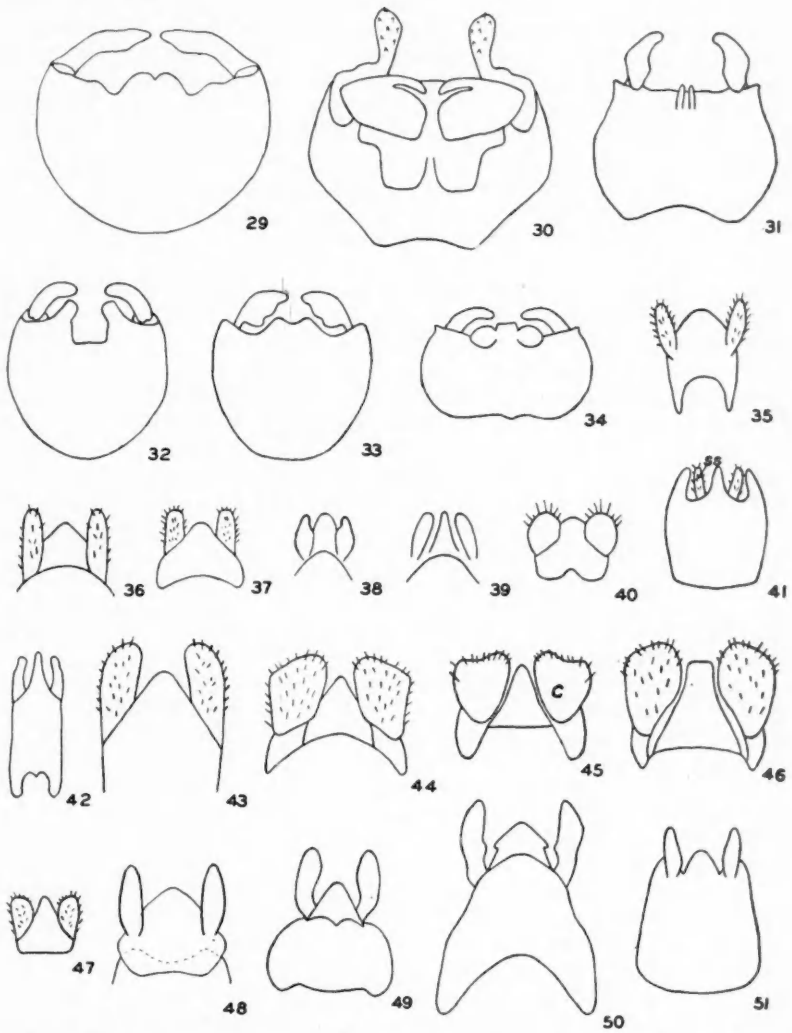
Males of *Microchrysa polita* (L), the lone representative of *Microchrysa* collected in Wisconsin were dissected but the minute size of the genitalia did not allow accurate drawings with the techniques used.

In the genus *Sargus*, dissections were made of the four species found in Wisconsin, including the genotype, *Sargus cuprarius* (L.) (figs. 17, 34, 49). Within this genus there seems to be considerable variation in the genitalia. The genotype and *S. viridis* Say (figs. 14, 32, 48) have aedeagi with two central prongs; *S. clavis* Will. (figs. 15, 31, 50) and *S. decorus* Say (figs. 16, 33, 51) have aedeagi with three central prongs. There is also variation in the shape of the styles. The styles place *S. cuprarius* and *S. viridis* together with notched inner margins and *S.*



FIGS. 1–17. Aedeagi. 1. *Actina viridis* (Say). 2. *Allognosta fuscitarsis* (Say). 3. *Euparyphus tetraspilus* Loew. 4. *Oxycera albovittata* Mall. 5. *Nemotelus unicolor* Loew. 6. *Berkshiria aldrichi* (Mall.). 7. *Cephalochrysa nigricornis* (Loew). 8. *Ptecticus trivittatus* (Say). 9. *Stratiomys discalis* Loew. 10. *Odontomyia cincta* Latr. 11. *Anoplodonta nigrirostris* (Loew). 12. *Hoplitimyia constans* (Loew). 13. *Labostigmina flavicornis* (Latr.). 14. *Sargus viridis* Say. 15. *Sargus clavis* Will. 16. *Sargus decorus* Say. 17. *Sargus cupraris* (L.).

FIGS. 18–28. Genitalia, ventral views. 18. *Actina viridis* (Say). 19. *Allognosta fuscitarsis* (Say). 20. *Euparyphus tetraspilus* Loew. 21. *Oxycera albovittata* Mall. 22. *Nemotelus unicolor* Loew. 23. *Berkshiria aldrichi* (Mall.). 24. *Ptecticus trivittatus* (Say). 25. *Stratiomys discalis* Loew. 26. *Odontomyia cincta* Latr. 27. *Anoplodonta nigrirostris* (Loew). S, style. 28. *Hoplitimyia constans* (Loew).



FIGS. 29–34. Genitalia, ventral views. 29. *Labostigmina flavicornis* (Latr.). 30. *Cephalochrysa nigricornis* (Loew). 31. *Sargus clavis* Will. 32. *Sargus viridis* Say. 33. *Sargus decorus* Say. 34. *Sargus cuprarius* (L.).

FIGS. 35–51. Genitalia, dorsal views. 35. *Cephalochrysa nigricornis* (Loew). 36. *Allognosta fuscitarsis* (Say). 37. *Actina viridis* (Say). 38. *Oxycera albovittata* Mall. 39. *Nemotelus unicolor* Loew. 40. *Euparyphus tetraspilus* Loew. 41. *Ptecticus trivittatus* (Say). SS, surstyli. 42. *Berkshiria aldrichi* (Mall.). 43. *Anoplodonta nigrirostris* (Loew). 44. *Odontomyia cincta* Latr. 45. *Hoplitimyia constans* (Loew). C, cercus. 46. *Labostigmina flavicornis* (Latr.). 47. *Stratiomys discalis* Loew. 48. *Sargus viridis* Say. 49. *Sargus cuprarius* (L.). 50. *Sargus clavis* Will. 51. *Sargus decorus* Say.

clavis and *S. decorus* together with plainly curved inner margins. The four species of this genus have been worked into an experimental key using genitalia as the basis of species separation.

Ptecticus trivittatus (Say) (figs. 8, 24, 41) represents the genus *Ptecticus*. The aedeagus which has only one central prong resembles the shape of a rolling pin; the styles are small; the dorsal parts possess three surstyli which are the only examples of surstyli found in the Wisconsin species of Stratiomyidae dissected.

Cephalochrysa nigricornis (Loew) (figs. 7, 30, 35), is the single representative of *Cephalochrysa*. The aedeagus has three thin prongs; the styles of the ventral genitalia are very distinctly "mitt-shaped" and the spiny projections of the ventral parts set this genus off from all other genera in this study.

In the subfamily Stratiomyinae, the three genera, *Stratiomys*, *Odontomyia* and *Labostigmina* are represented by twenty-three species. The genera, *Hoplitimyia* and *Anoplodonta*, although not recorded in Wisconsin are included in this genitalia discussion for comparisons.

Stratiomys discalis Loew (figs. 9, 25, 47) represents *Stratiomys*. The three-pronged aedeagus is distinctly "arrow-shaped" and is completely different from aedeagi in other genera. The styles are quite similar to those of *Labostigmina* and *Hoplitimyia;* the dorsal part of the genitalia is not distinctive.

Odontomyia cincta Latr. (figs. 10, 26, 44) has a three-prong aedeagus with the outer prongs tapering from the tip on the outer edge; the center prong is rounded; the styles are rather compacted and resemble those of *Anoplodonta*.

The genus *Labostigmina*, like *Anoplodonta*, has been separated from *Odontomyia* in recent years. It is represented by *L. flavicornis* (Latr.) (figs. 13, 29 46) which has a three-pronged aedeagus almost identically like that of *Anoplodonta nigrirostris* (Loew) (figs. 11, 27, 43). The styles of *L. flavicornis* are elongate, however, while those of *A. nigrirostris* are compacted. The dorsal parts of the two are very similar. Of the generic representatives dissected in this study, *Labostigmina* and *Anoplodonta* show the most similarities, indicating close relationships.

Hoplitimyia constans (Loew) (figs. 12, 28, 45) represents the genus *Hoplitimyia*, which has been separated from *Stratiomys* in recent years. This genus varies markedly from other genera by the "lyre-shaped" aedeagus. The elongate styles which are shaped like the head of a water bird show some similarity to the styles of *Labostigimina*. The dorsal parts are very similar to those of *Odontomyia* and *Labostigmina*. Externally these five genera of Stratiomyinae are separated primarily on the length of antennal segments and antennal form. Probably genitalia studies would lend themselves readily to generic separation in the Stratiomyinae.

The subfamily Clitellarinae has three Wisconsin genera, *Nemotelus*, *Oxycera* and *Euparyphus*. Externally these three genera are easily separated. *Oxycera* has an aristate antenna, *Nemotelus* has the face produced to a pointed snout and *Euparyphus* has a receding face. The genitalia show somewhat less decisive differences. *Oxycera albovittata* Mall. (figs. 4, 21, 38) has the styles and ventral parts shaped similarly to those of *Euparyphus tetraspilus* Loew (figs. 3, 20, 40). The aedeagi

of the two are also similar. ***Nemotelus unicolor*** Loew (figs. 5, 22, 39) has a three-pronged aedeagus with the outer prongs decurved. The styles are greatly elongated and apodemes extend beyond the styles.

The subfamily Beridinae is represented by *Actina* and *Allognosta*. The two are easily distinguished externally by the four-spined scutellum of *Actina* and the spineless scutellum of *Allognosta*. They are also easily separated by the male genitalia. ***Actina viridis*** (Say) (figs. 1, 18, 37) has an aedeagus with three very shallowly cut prongs and the styles are small and hairy. ***Allognosta fuscitarsis*** (Say) (figs. 2, 19, 36) the genotype, has a three-pronged aedeagus with the prongs deeply cut and the elongated styles curved strongly inward.

The subfamily Pachygasterinae is represented by three genera, ***Pachygaster***, ***Neopachygaster*** and ***Berkshiria***. Only the genitalia of ***Berkshiria aldrichi*** (Mall.) (figs. 6, 23, 42) were large enough to lend themselves to accurate drawing. The whole structure seems proportionally longer than other genitalia. The aedeagus is "spear-shaped" with two prongs which seem to have fine hairs along the outer margin at their distal ends. The styles are elongate with rounded tips.

From these studies of representative genera of Stratiomyidae, two keys have been prepared, based entirely on the male genitalia; the first one to the genera that occur in Wisconsin and those closely related, and a second to the four species of *Sargus* that have been found in Wisconsin.

GRAPHIC KEY TO THE GENERA

(Based on Genitalia)

1. "Arrow-shaped" aedeagus (fig. 9) ..... **Stratiomys** Geoffroy
   One-, two- or three-pronged aedeagus 2
2. One- or two-pronged aedeagus 3
   Three-pronged aedeagus 5
3. One-pronged aedeagus; aedeagus resembles a rolling pin; surstyli present (figs. 8, 41) ..... **Ptecticus** Loew
   Two-pronged aedeagus 4
4. Aedeagus "spear-shaped"; styles resembling sheep's horns (figs. 6, 23), ... **Berkshiria** Johnson
   Aedeagus fleshy; styles half-mooned shaped; ventral genitalia broad (figs. 17, 34) ..... **Sargus** Fabricius
5. Three prongs on aedeagus very shallowly cut; small spiny styles (figs. 1, 18), ... **Actina** Meigen
   Three prongs on aedeagus deeply cut 6
6. Spiny projections present on ventral genitalia; "mitt-shaped" styles (fig. 30) ..... **Cephalochrysa** Kertész
   Spiny projections absent on ventral genitalia 7
7. Outer prongs cut off on outer edge (fig. 10) ..... **Odontomyia** Meigen
   Outer prongs rounded on outer edges 8
8. Aedeagus "lyre-shaped"; styles resembling head of a water bird (figs. 12, 28), ... **Hoplitimyia** James
   Aedeagus not "lyre-shaped" 9
9. Outer prongs curved strongly outward; styles elongate (fig. 5) ..... **Nemotelus** Geoffroy
   Outer prongs not curved outward 10
10. Styles notched on inner side; ventral genitalia broader than long (fig. 20), ... **Euparyphus** Gerstaecker
    Styles elongate or compacted 11
11. Styles compacted 12
    Styles elongated 13

12. Large genitalia; styles very rounded on all edges (fig. 27)...**Anoplodonta** James
Styles pointed on inner edges (fig. 21).....**Oxycera** Meigen
13. Large genitalia; cerci rounded; aedeagus prongs rounded on edges (fig. 13),
.....**Labostigmina** Enderlein
Aedeagus outer prongs cut off on inner side; styles curved inward (figs. 3, 19),
.....**Allognosta** O. S.

KEY TO THE SPECIES OF SARGUS

(Based on Genitalia)

1. Prongs of aedeagus shallowly cut; styles notched on inner margins (figs. 16, 33).....**decorus** Say
Prongs of aedeagus deeply cut; styles smoothly curved on inner margins (figs. 15, 32).....2
2. Ventral genitalia much broader than high (fig. 34).....**cuprarius** (L.)
Ventral genitalia higher or as high as broad.....3
3. Aedeagus extremely elongate; dorsal genitalia about one-half as large as ventral genitalia (figs. 14, 32, 48).....**viridis** Say
Aedeagus moderately stout; dorsal genitalia larger than ventral genitalia (figs. 15, 31, 50).....**clavis** Will.

THE WONDERFUL WORLD OF INSECTS, by Albro T. Gaul. Pp. 290, 47 plates. Rinehart and Company. 1953. Price $4.00.

In recognition of the importance of amateurs and amateurism in the building of biological theory and in the cultural life of a nation, this book is directed to those who can carry on entomological pursuits as a hobby, either alone or as part of an interest in another field such as photography or electronics. The author has obviously come from the ranks of the hobbyist to those of the professional; he has dedicated his book to his grandmother, "whose permission to keep test tubes in the icebox and wasps in the windows has culminated in this volume." He writes interestingly and in non-technical language, presenting his ideas with striking freshness and illustrating his work with full-page photographs, some exceptional and most of them good. He covers a wide range of subjects dealing with various aspects of insect life and biology, but he hardly lives up to the claim of the blurb on the jacket, to give us "all this is known about insects as parasites, friends and foes"!

The author is at his best in the field with which he is most familiar. His account of social insects is colorful. The chapter on "Insects in business" presents a phase of entomology which is little known even to the professional, but which unfortunately is marred by a short paragraph (bottom of page 183) beginning with a grammatical error and containing in its eleven lines, several over-generalizations and misstatements. The author corrects some misconceptions, but creates others of his own. For example, on page 95 he confuses the ox warble fly with *Dermatobia;* on page 30 he translates Odonata as the "toothless ones"; and on page 100 he infers that black flies transmit the filarial worms that cause elephantiasis. These errors are all the more serious because they are directed to readers who do not have the background to recognize them as such. It is a pity that a book, basically so good, was not submitted to critical readers prior to publication.—M. T. J.

TAXONOMY AND HYBRIDIZATION IN THE CARDINI GROUP OF DROSOPHILA

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INTRODUCTION

Recent studies on the taxonomy of the Drosophilidae have shown that in many cases species groups thought to be represented by one or a few species actually consist of many species, often so similar morphologically that they are readily and repeatedly confused. One such group, that to which *Drosophilia cardini* belongs, is of special interest, not only because it contains at least two species showing striking and clear-cut polymorphism in the abdominal banding pattern (a situation unusual for *Drosophila*), but also because at least two members of the group may occasionally reproduce by diploid parthenogenesis (Stalker, 1951 and unpublished). It is the purpose of this paper to describe two new North American members of the group, as well as to report some experimental hybridizations which have been carried out.

The discussion of the taxonomy will for the most part be limited to those species known from Central and North America and from the West Indies. Species so included are: *D. polymorpha* Dobzhansky and Pavan, *D. cardini* Sturtevant, *D. similis* Williston, *D. cardinoides* Dobzhansky and Pavan, *D. neocardini* Streisinger, and two species to be described below: *D. acutilabella* sp. nov. and *D. parthenogenetica* sp. nov. Of the species listed above, *D. neocardini* is reported only from Brazil, but is included here because its morphological similarity to *D. parthenogenetica* has been the cause of confusion in the past.

The *cardini* group is a taxonomically difficult one. Sturtevant (1921), in discussing the two members known at that time, *D. cardini* and *D. similis*, states that he could find no reliable criteria for separation of these two species in pinned specimens. Streisinger (1948) also emphasizes the difficulty of separation of the species on morphological criteria alone, and concludes that "the most convincing and conclusive method of classification proved to be their behavior in crosses." The workers in the University of Texas Laboratory have run into the same difficulty in their extensive collections of material from the southwest and Florida.

The members of the group show striking differences in abdominal banding pattern. However, although this taxonomic character is at times very useful, it must be used with caution as all the species considered here show some intra-specific variability in abdominal banding, and in the case of two, *D. polymorpha* and *D. acutilabella*, this variability is so striking as to make any separation based solely on banding pattern completely unreliable.

Although it is clear that morphological criteria for separating the members of this group will probably never be wholly satisfactory,

it is also clear that any separation which is possible on these grounds is extremely valuable, not only in sorting and saving newly collected material, but also in order that the pinned material available may be more fully exploited. Accordingly a key designed to distinguish the above-mentioned species is presented. This key does not include those members of the group (at present known only from South America) which have either divergent anterior scutellars or a comb of short, stout bristles on the anterior surface of the fore-femora.

KEY FOR NORTH AND CENTRAL AMERICAN MEMBERS OF THE CARDINI GROUP

1. Several well-differentiated bristles on posterior surface of fore-femur in addition to one or two bristles on proximal fourth. Fore-femur lightly haired on posterodorsal surface (as in fig. 1K)..... 3

   No well-differentiated bristles on posterior surface of fore-femur in addition to one or two on proximal fourth. Fore-femur densely haired distally on posterodorsal surface, at least in male (as in fig. 1J)..... 2

2. Scutellum somewhat pointed at posterior tip when viewed from above; scutellar dorsal surface convex when viewed from side. Largest of posteriorly directed heavy spine-like bristles on flexor surface of fore-femur with a length equal to or greater than the greatest diameter of the femur (fig. 1J). Apical index about 1.7.

   Male: Fore-femur densely haired distally on posterodorsal surface. Labellum when viewed in profile shows slight protuberance on ventral edge about two-fifths of the distance from the posterior margin; anteroventral edge of labellum normally rounded (fig. 1A). Each clasper with parallel anterior and posterior row of heavy spine-like bristles (fig. 2E). (Brazil, Guatemala, Panama).....**polymorpha** Dobzhansky and Pavan

   Scutellum flattened or gently rounded at posterior tip when viewed from above, dorsal surface of scutellum nearly flat when viewed from side. Largest of posteriorly directed heavy spine-like bristles on flexor surface of fore-femur with a length not more than two-thirds greatest diameter of femur, often about one-half greatest diameter. Apical index about 2.3. Fore-femur in both sexes densely haired distally on posterodorsal surface.

   Male: Labellum when viewed in profile shows no ventral protuberance, and smoothly rounded posteroventral edge, but forms almost a right angle at the anteroventral edge (fig. 1G). Clasper lacking the anterior row of heavy spine-like bristles (fig. 2F). (Mexico).....**parthenogenetica** sp. nov.

3. Fourth-vein index about 1.5; crossveins dark but without clouds, palpi of both sexes roughly club-shaped with one or more well-differentiated bristles on anterolateral edge (figs. 2G, H). Last three abdominal segments in the female and last two in male more lightly pigmented than more anterior segments. (Brazil).....**neocardini** Streisinger

   Fourth vein index about 1.7; crossveins dark but without clouds; at level of anterior crossvein L2 is usually closer to costa than to L3, or may be equidistant from them. At level of termination of L5 in posterior margin of wing, L2 is closer to costa than to L3. Palpi of both sexes very broad and rounded when viewed from below, and with hairs or weakly differentiated bristles on both medioventral and lateroventral surfaces (figs. 2 O, P, Q, R). In the male the palpi completely lacking any differentiated bristles, with anterior portion of ventral surface turned up so that it forms an anteroventral face. Last three abdominal segments in female and last two in male darker than more anterior segments. (Brazil, Central America).....**cardinoides** Dobzhansky and Pavan

   Fourth-vein index about 1.7; crossveins with clouds. At level of anterior crossvein L2 is closer to L3 than it is to costa. At level of termination of L5 in posterior margin of wing L2 is equidistant from L3 and costa. Palpi of both sexes roughly club-shaped, with one or more well-differentiated bristles on anterolateral edge (as in figs. 2 I, J)..... 4

4. *Male:* Labellum when viewed in profile shows a prominent horn-like

protuberance on anteroventral edge (fig. 1 B). Anteromedial corner of anal plate with single long bristle which is strongly curved laterally. This bristle attached to prominent anterior process of anal plate (fig. 2 C). (Florida, Cuba) ..... **acutilabella** sp. nov.

Male: Labellum when viewed in profile shows no protuberance on margin. Anal plate with one or two (rarely three) long, almost straight, anteriorly directed bristles on anteromedial corner (fig. 2 A). (West Indies, Florida, Central America, Mexico, Texas?) ..... **cardini** Sturtevant

There appears to be no simple and completely accurate way of separating females of *D. acutilabella* and *D. cardini* morphologically. However, since the light form of *D. acutilabella* (see description) is fairly common and since a comparable light form of *D. cardini* is not known, a mature female which keys to couplet 4 and is light is probably *D. acutilabella* rather than *D. cardini.*

Drosophila acutilabella sp. nov.

Male.—Arista exclusive of terminal fork with about five branches above and two below. Antenna light brown, third joint not noticeably darker. Front more than one-third width of head; front and vertex velvety golden-brown. Triangle and orbits slightly darker and somewhat shiny. Middle orbital about one-fifth other two. Second oral about four-fifths length of first. Carina large, broad below, not sulcate; flattened anterior surface somewhat pollinose. Face pale tan. Cheeks shining light brown, becoming darker anteriorly, their greatest width about one-fifth greatest diameter of the eye. Eyes with short pile which is golden ventrally, darker dorsally. Maxillary palpi pale yellowish-brown, with bristle at tip and two to three smaller bristles along lateral margin (see fig. 2 I). Labellum when viewed from side shows a very distinct anteroventrally directed horn at its lower anterior margin (see fig. 1 B).

Acrostichal hairs in six rows; no prescutellars. Anterior scutellars convergent. Mesonotum and scutellum shining yellowish-brown without a distinct pattern. Scutellum somewhat darker. Pleurae light brown. Anterior sternopleural about 0.4 length of posterior; median sternopleural varies from an undifferentiated hair to a bristle about 0.4 length of anterior. Halteres light brown with blackish areas on anterior surface of base and bulb. Legs light brown. Numerous recurved hairs on fore-tarsi. Fore-femora with several well differentiated bristles on distal two-thirds of posterior surface, in addition to one or two bristles on basal third. Largest of posteriorly directed, heavy spine-like bristles on flexor surface of fore-femur with a length nearly equal to the greatest width of the femur (fig. 1 K). Apical bristles on first and second tibiae, preapicals on all three.

Wings clear, crossveins slightly clouded. Two prominent bristles at apex of first costal section. Costal index about 3.3; fourth vein index about 1.7; 5x index about 1.2; 4c index about 0.8; apical index (length of third section of the costal vein divided by the length of its fourth section) about 1.7. Third costal section with heavy bristles on its basal two-fifths. Abdomen shining, yellowish-brown with black areas as described below.

Dark Form: First visible tergite with short, narrow posterior band restricted to median third of tergite and sometimes weakened in the

mid-line. Second tergite with longer band which may be produced anteriorly in the middle. Third tergite with posterior band showing notch in mid-line and with anteriorly produced lateral extensions which may or may not be broken free from body of band. Fourth tergite solid black except for lateral margins and clear area in mid-dorsal region. Tergites 5 and 6 solid black except for lateral margins.

Light Form: As above except that the black bands in tergites 1 and 2 are interrupted medially; band in tergite 3 is more deeply notched medially and lacks anterior processes. In tergite 4 lateral anterior processes are usually broken free from main band, and median clear area is usually open anteriorly. Tergite 5 usually has two clear spots on anterior half on either side of the mid-line. Tergite 6 solid black except at lateral margins.

Female.—Fewer recurved hairs on fore-tarsi. Labellum "normal" when viewed from side, that is, lacking antero-ventral horn (Fig. 1E). Abdomen shining, yellowish-brown, with black areas as described below.

Dark Form: First and second tergites as in male. Tergite 3 with posterior band showing anterior notch in mid-line and no anterior processes. Band in tergite 4 with median notch and prominent lateral anterior processes which may extend medially so as to enclose central clear area. Tergites 5 to 7 solid black except for lateral margins.

Light Form: Tergites 1 to 6 with narrow posterior band which is either greatly weakened or broken in the mid-line. Posterior band in tergite 6 very narrow. This tergite may have small median anterior black spot. Tergite 7 with median black area on either side of and above anal plates. The black bands do not reach the lateral margins of the tergites in any segment.

Length of body 2.3 mm; wing 2.3 mm.

The polymorphism in the abdominal pattern is apparently inherited in a simple Mendelian fashion, with the heterozygote phenotypically very close to the light form.

Internal Structures: A single anterior Malpighian tube, branches only at its distal sixth; posterior tubes with ends apposed without formation of continuous lumen. Testis light yellow, about six outer and three inner gyres. Vasa efferentia long slender and colorless. Sperm pump with two long diverticula. Spermathecae light brown, chitinized portion of bulb vase-shaped with the greatest diameter less than the height.

Eggs: with four long acuminate filaments.

Larva: The larvae skip.

Metaphase Chromosomes: 2 pairs of V's, 1 pair of rods and 1 pair of dots.

Puparium: reddish brown; pupal horns (including spiracle branches) about one-fifth length of body of puparium. About nine spiracular branches which are blackish proximally, becoming grayish-brown toward their tips. Stalk of pupal horn with black ring at base of spiracle branches; stalk about equal in length to longest branches.

Holotype male.—Holotype and paratype descendents of a single female from St. Petersburg, Florida; to be deposited in the American Museum of Natural History.

Drosophila parthenogenetica sp. nov.

Male.—Arista exclusive of terminal fork with about five branches above and two below. Antenna yellowish-brown, third joint not noticeably darker. Front over one-third width of head; front and vertex light velvety brown. Triangle and orbits somewhat lighter and slightly shining. Middle orbital about one-fourth anterior which is four-fifths posterior. Second oral about four-fifths length of first.

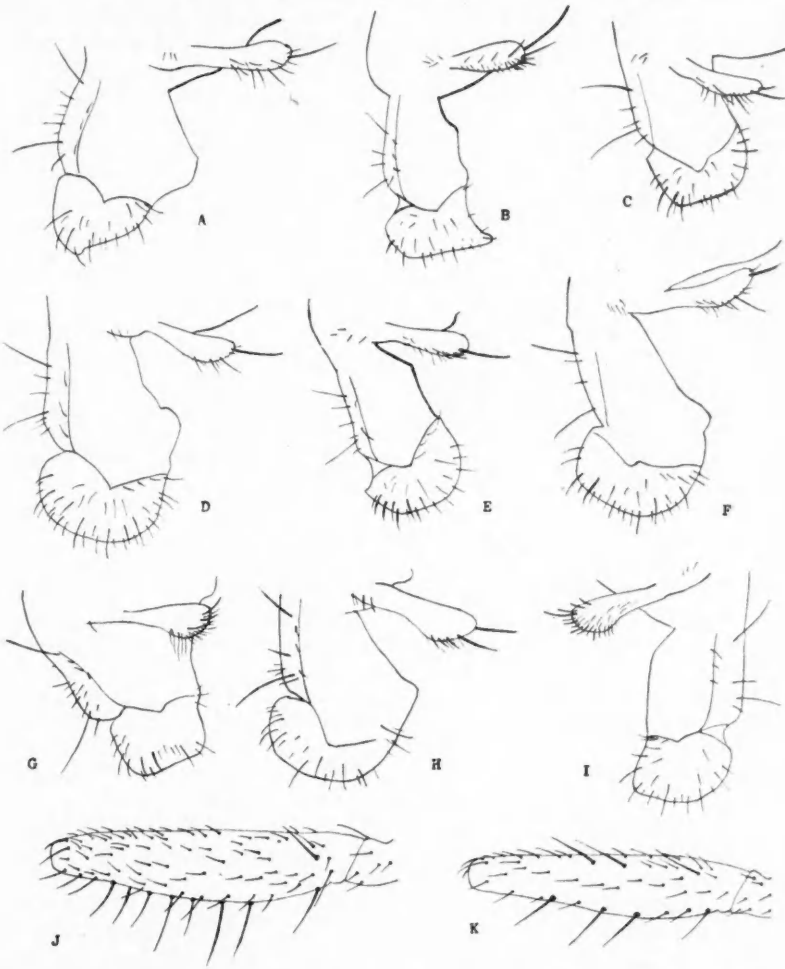

FIG. 1. Proboscis and palp, lateral view. A. *D. polymorpha* male. B. *D. acutilabella* male. C. *D. neocardini* male. D. *D. polymorpha* female. E. *D. acutilabella* female. F. *D. neocardini* female. G. *D. parthenogenetica* male. H. *D. parthenogenetica* female. I. Hybrid male (*D. acutilabella* female X *D. cardinoides* male).

Left fore-femur, posterior view. J. *D. polymorpha* male. K. *D. acutilabella* male.

Carina large, broad below, not sulcate, pollinose on flattened anterior surface. Face shining light brown. Cheeks shining yellowish-brown, their greatest width about one-sixth greatest diameter of the eye. Eyes with short, thick pile, blond below, darker above. Maxillary palpi light yellowish-brown with about five differentiated bristles on ventral anterolateral margin (fig. 2 K). Labellum when viewed from side with angular rather than rounded anteroventral edge (fig. 1 G).

Acrostichal hairs in six rows; no prescutellars. Anterior scutellars convergent. Mesonotum and scutellum shining yellowish brown without a distinct pattern. Pleurae light yellowish-brown. Anterior sternopleural about 0.4 length of posterior; median sternopleural form one-sixth to one-half length of anterior. Halteres light brown. Legs pale yellowish-brown, apicals on first and second tibiae, preapicals on all three. Fore-femur densely haired distally on posterodorsal surface as in *D. polymorpha* (as in fig. 1 J). Largest of posteriorly directed, heavy spine-like bristles on flexor surface of fore-femur with a length not more than two-thirds greatest diameter of femur, often equal to about one-half greatest diameter. No well differentiated bristles on posterior surface of fore-femur in addition to one or two on proximal third. Numerous recurved hairs on fore-tarsi.

Wings light brownish-gray, clear except for light clouds at cross-veins. Veins light brown. Two bristles at distal costal break, but ventral one very weakly differentiated. Heavy bristles on basal two-fifths of third costal section. Costal index about 3.4; fourth vein index about 1.5; 5x index about 1.1; 4c index about 0.5; apical index (length of third section of the costal vein divided by the length of its fourth section) about 2.3.

Abdomen shining light brownish-yellow. Segments 2 to 6 with narrow black band on posterior edge, widely interrupted medially, and failing to reach lateral margin of tergite in any segment; bands are weak (or absent in young specimens) on tergites 5 and 6. Bands on all segments tend to show anterior processes laterally which never reach anterior margin. These processes are especially noticeable on segments 3, 4 and 5.

Females.—Anteroventral edge of labellum normally rounded when viewed from side, not angular as in male (fig. 1 H). Maxillary palpi not so broad when viewed from ventral surface, number of bristles on ventral anterolateral margin usually three to four (fig. 2 L). Fore-femur less densely haired on posterodorsal surface. Hairs on tibiae shorter, not recurved. Abdominal black bands show more strongly developed anterior processes at their lateral edges. Seventh tergite with median black spot above anal plates.

Length of body 2.1 mm; wing 2.0 mm.

Chromosomes: 2 pairs of V's, 1 pair of rods (with strong secondary constriction), 1 pair of dots.

Puparium: Reddish brown; pupal horns (including spiracle branches about one-sixth length of body of puparium. About nine spiracle branches which are light grayish-brown in color. Stalk of pupal horn with black ring at base of spiracle branches; stalk about equal in length to longest branches.

Larva: The larvae skip.

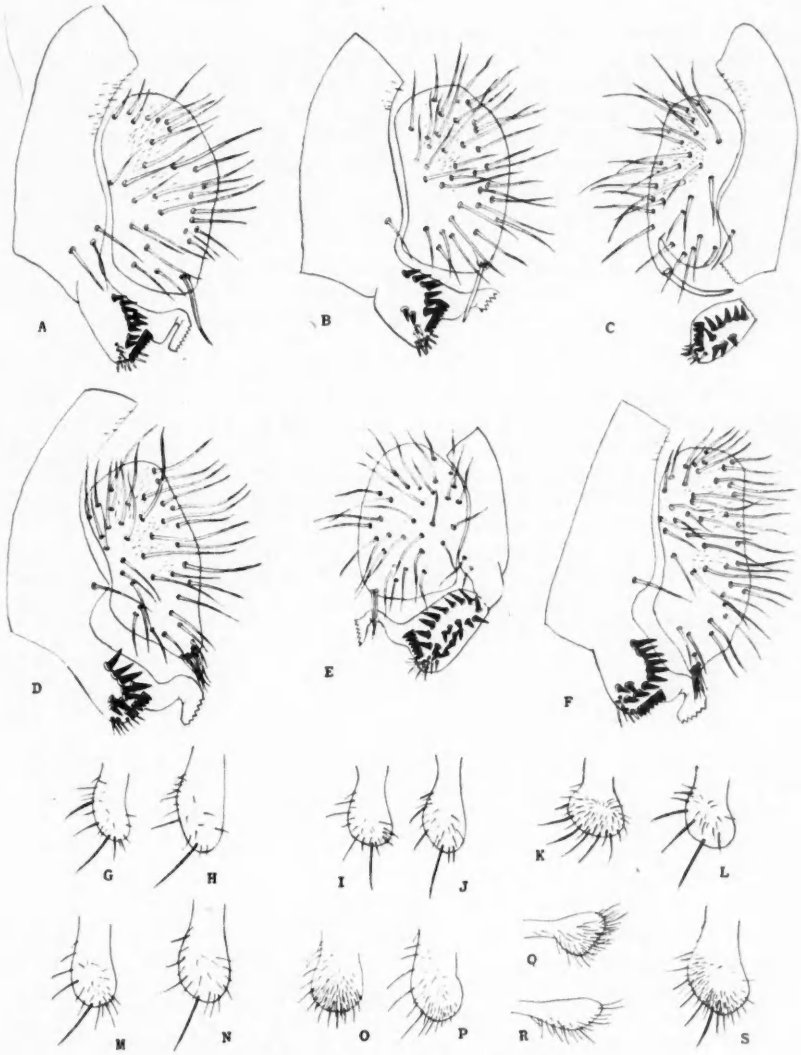

FIG. 2. Male external genitalia showing half genital arch, one anal plate and one clasper. A. *D. cardini*, Florida strain, left half. B. Hybrid, left half (*D. acutilabella* female X *D. cardini* male). C. *D. acutilabella*, right half. In this figure the clasper is shown removed from its normal attachment to the genital arch (indicated by the jagged line), and moved down in order to show more clearly the long, laterally curved anal plate bristle. D. *D. cardinoides*, Guatemala strain, left half. E. *D. polymorpha*, Brazil strain, right half. F. *D. parthenogenetica*, Atlixco strain, left half.

Ventral view of the left palpus, anterior end down in figure. G. *D. neocardini* male. H. *D. neocardini* female. I. *D. acutilabella* male. J. *D. acutilabella* female. K. *D. parthenogenetica* male. L. *D. parthenogenetica* female. M. *D. polymorpha* male. N. *D. polymorpha* female. O. *D. cardinoides* male. P. *D. cardinoides* female. S. Hybrid male (*D. acutilabella* female X *D. cardinoides* male).

Lateral view of right palpus. Q. *D. cardinoides* male. R. *D. cardinoides* female.

Eggs: With four long acuminate filaments.

Internal Structures: A single anterior Malpighian tube, branching only at its distal sixth; posterior tubes with ends apposed without formation of continuous lumen. Testis very pale yellow, about six outer and three inner gyres. Vasa efferentia long slender and colorless. Sperm pump with two long divericula. Spermathecae light brown, chitinized portion of bulb vase-shaped, with the greatest diameter less than the height. Long, thin ventral sperm receptacle with about 45 gyres.

Holotype male.—Holotype and paratype members of a laboratory strain from Atlixco, Mexico; to be deposited in the American Museum of Natural History.

THE EXTERNAL GENITALIA IN THE CARDINI GROUP

Studies of the ovipositor plates of the females in this group have shown little constant interspecific variability, and it appears that the female externalia are of little taxonomic value here. In the case of the males, Hsu (1949) in his survey of the Drosophilidae presented figures for *D. cardini*, *D. cardinoides* and *D. parthenogenetica*, (listed in his paper as *D. neocardini*). Figure 2 in this paper shows the external male genitalia of these species as well as those of *D. polymorpha* and *D. acutilabella*. Our figures for *D. parthenogenetica* and *D. cardinoides* agree fairly well with those of Hsu; however, the figure for *D. cardini* does not. In this species Hsu shows a fringe of short hairs on the antero-ventral edge of the anal plate, lateral to the long, anteriorly directed anal plate bristles. We have been unable to find any such fringe in *D. cardini*. Dr. Hsu has kindly re-examined his preparations and finds that his original figure was in error.

It will be noted that the male genitalia permit clear identification of three members of the group, *D. cardini*, *D. acutilabella* and *D. polymorpha*. The other three species (including *D. neocardini* which is not figured), are so similar that it is very difficult to obtain consistent separation on this basis.

THE METAPHASE CHROMOSOME CONFIGURATIONS

The members of the group treated in this paper fall into two general categories. *D. cardini* and *D. similis* resemble each other in having five pairs of rod-shaped chromosomes and one pair of dots, the determinations of Metz (1916) being based on strains from Cuba.

The remaining five species have two pairs of V-shaped chromosomes, one pair of rod-shaped chromosomes and a pair of dots. The descriptions of the chromosomes in *D. polymorpha*, *D. cardinoides*, and *D. neocardini* were based on Brazilian strains (Dobzhansky and Pavan 1943, Streisinger, 1946). The chromosomes of *D. acutilabella* have been very kindly examined by Dr. H. L. Carson, his determination being based on a St. Petersburg, Florida strain. The chromosomes of the Atlixco strain of *D. parthenogenetica* are reported by Wheeler (1949), and have been re-examined by Dr. Carson and by the author.

NOTES ON IDENTIFICATION AND DISTRIBUTION

Drosophila acutilabella, new species

Several strains of this species were collected from St. Petersburg,

Florida by the author in August of 1950 (type collection). Additional strains from Florida are as follows: Everglades (Texas workers), Winter Park (Mrs. H. H. Plough), Lake Placid (J. I. Townsend).

The Sturtevant collection contains specimens from Cristo and Herradura (C. W. Metz), Cuba. In addition female specimens from Lakeland, Miami and Tampa, Florida and from Panama may belong here since they have the light abdominal pattern characteristic of some *D. acutilabella*, and so far unknown in *D. cardini*. This species is readily confused with *D. cardini* in pinned material, but some relaxed males may be separated with certainty by the genitalia.[1]

Drosophila parthenogenetica, new species

This species, formerly confused with *D. neocardini* from Brazil, is known only from a single strain collected in Atlixco, Mexico (Patterson and Mainland, 1944), and generously provided by Dr. M. R. Wheeler.

Virgin females of this species will occasionally lay eggs which begin development; about 90% of the embryos die prior to hatching, the remainder may form normal fertile diploid females or (rarely) sterile diploid XO males (Stalker, 1951).

Drosophila cardini Sturtevant

Sturtevant (1921) lists this species from Cuba, Haiti, Porto Rico, Dominica, Costa Rica, Republic of Panama and Florida. Since *D. cardini* is liable to be confused with *D. acutilabella*, some of these records may actually represent the latter species. A separation of the two species is often possible in relaxed pinned males, and a survey of the material in the Sturtevant collection from the following localities indicated that it was clearly *not D. acutilabella*, and probably was *D. cardini:* Santiago de las Vegas, Havana (paratypes), Cuba; Miami, Florida; Republic of Panama.

In addition recently collected strains from St. Petersburg (H. D. Stalker), Lake Placid (J. I. Townsend), Everglades, Myakkas Head (Texas workers), Florida; Cuba (J. I. Townsend); Durango, Mexico City, Oaxaca, Monterey, Atlixco (Wheeler and Wagner) Mexico, belong here. The collections from Texas, New Mexico, Arizona, Guatemala and Costa Rica (Wheeler and Wagner, 1943) are not at present represented by living strains, and it is possible that some of these records may be for other members of the group.

Drosophila polymorpha Dobzhansky and Pavan

Dobzhansky and Pavan (1943) record this species from various localities in the State of São Paulo, and from the Federal District, Brazil. The Sturtevant collection contains specimens from these additional localities: Quirigua Guatemala (Th. Dobzhansky); Corumba, Matto Grosso, Brazil (R. G. Harris); Panama, Republic of Panama (A. H. Sturtevant).

In this species, as in *D. parthenogenetica*, virgin females will on rare occasions produce fertile diploid daughters.

[1]In a personal communication, Dr. M. R. Wheeler reports that out of 825 *D. cardini* group males trapped from ten localities in peninsular Florida by the Texas workers (June, 1953), fifty-one percent were *D. cardini* and the remaining forty-nine percent were *D. acutilabella*.

Drosophila neocardini Streisinger

Streisinger (1948) described this species from Teffe, Amazonas, Brazil. Wheeler (1949) in discussing the confusion in the group states that a strain collected from Atlixco, Mexico (Patterson and Mainland, 1944), and differing from Streisinger's type strain cytologically only in the shape of the Y-chromosome, also belonged to the species. The original Brazilian strain was not available at that time, but a more recent direct comparison of the Brazilian and the Mexican strains has shown that the latter represents a different species, described in this this paper as *D. parthenogenetica*.

Drosophila cardinoides Dobzhansky and Pavan

Dobzhansky and Pavan report this species from the State of São Paulo and from the Federal District of Brazil. Wheeler (1949) reports it from Guatemala City, Guatemala. He also states that the strain from Lake Okeechobee, Florida, examined cytologically by Wharton (1943), and considered to be *D. cardini* at that time, was probably *D. cardinoides* also. This strain was clearly not *D. cardini* as indicated by its metaphase chromosome configuration, but since the chromosome pattern would fit either *D. cardinoides* or *D. acutilabella*, and since the former species is unknown from Florida and the West Indies, it seems probable that Wharton was dealing with *D. acutilabella* rather than *cardinoides*.

The Sturtevant collection contains specimens from Port Limon, Costa Rica; and from Panama.

Drosophila similis Williston

No stocks of this species are now known to exist, and since the collections cited by Sturtevant (1921) this species has apparently not been knowingly collected anywhere. Furthermore none of the specimens at present in the Sturtevant pinned collection are known to belong here. Sturtevant has pointed out that although *D. similis* and *D. cardini* would not cross in the laboratory, they were morphologically so similar that he was unable to devise means of distinguishing pinned specimens of the two species. He lists *D. similis* from: Herradura, Havana, Santiago de las Vegas, Bartle and Cristo in Cuba; Porus and Port Antonio in Jamaica; St. Vincent (Williston type material), and Bay Mansion in Barbados. Sturtevant also states that he has examined specimens from Florida, Haiti, Trinidad, Panama, Honduras and Mexico, which he concluded might belong here, concluding " . . . the lack of any really satisfactory character to separate this species from pale specimens of *D. cardini* Sturtevant makes all these latter determinations doubtful."

Thus it appears that while *D. similis* was taken in the West Indies, the Florida records are uncertain. *D. cardini* appears in collections from both areas and *D. acutilabella* from Flordia and Cuba. The great similarity of *D. cardini* and *D. acutilabella*, plus the fact that certain individuals of the latter species are lighter than *D. cardini*, certainly suggests that *D. acutilabella* and *D. similis* might be synonyms. The one fact which prevents this interpretation is that in *D. similis*, Metz (1916) has reported the metaphase chromosomes as five pairs of rods

and a pair of dots, while in *D. acutilabella* there are two pairs of V's, a pair of rods and a pair of dots.

The University of Texas workers, in their keys, (Patterson and Wheeler, 1943; Wheeler, 1949), have indicated a possible separation of *D. similis* from *D. cardini* on the basis of the anterior scutellars being divergent in the former species, convergent in the latter. Dr. Wheeler

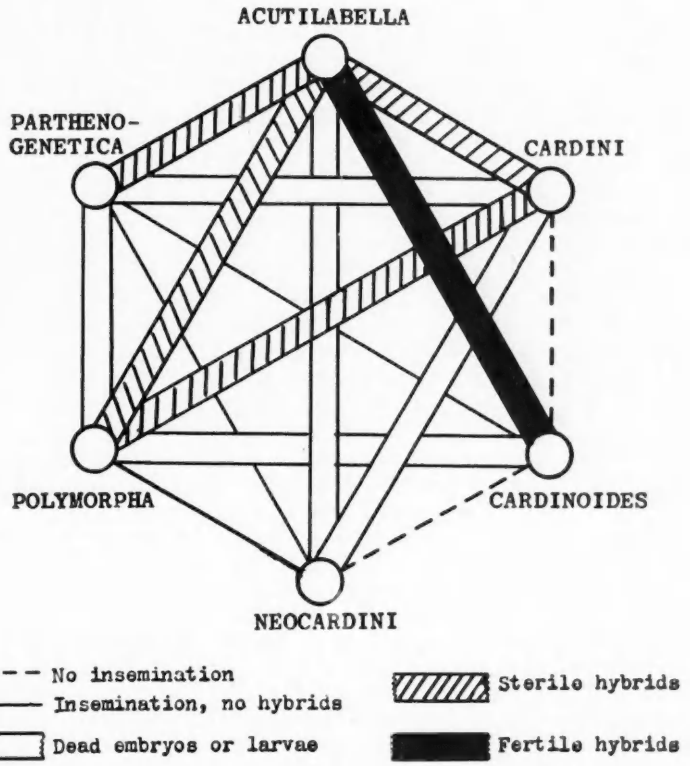

FIG. 3. Crossing Diagram for the *D. cardini* group. In this diagram the type of line or bar connecting any two species indicates the degree to which interspecific matings or hybrid production occur. Each connection shows the maximum crossability of the two species, considering both reciprocal crosses (except in the case of *D. parthenogenetica* where crosses using this species as the female are not included since large numbers of clearly impaternate (non-hybrid) progeny were always produced in such cases).

(personal communication) informs me that he no longer feels such a criterion reliable; thus the Texas records of *D. similis* from Florida, Texas and Mexico are open to question.

Thus, with the information available, one might expect that *D. similis* and *D. cardini* could be distinguished now only by cross-mating tests. Such tests between a group of strains assumed to be *D. cardini* might reveal one or more strains showing reproductive isolation from the

remainder if the group happened to include *D. similis*. A total of 80 such mating tests have been made between various members of the following 59 strains: Florida: St. Petersburg (18), Lake Placid (32), Myakkas Head (2), Everglades (1). Cuba (1), Mexico: Mexico City (1), Durango (1), Oaxaca (1), Monterey (1), Atlixco (1).

In all of these test crosses, mating occured promptly and larvae and adults were readily obtained. In the majority of crosses these adults proved to be fertile; in some cases they were not aged sufficiently to be tested for fertility. Although only certain crossing combinations were tried, it is assumed that in this case any two strains which cross readily with a third would cross with each other. Thus none of the 59 strains considered to be *D. cardini* showed any indication of cross-sterility with any of the others.

It is of course not certain whether the above strains actually belong to the species *D. cardini*, or whether they are all *D. similis*. However, since Sturtevant's records seem to indicate that *D. cardini* was the commoner of the two species, at least in Florida prior to 1916, it seems likely that the strains collected there in recent years, as well as those from Mexico actually are *D. cardini*. Recent collections of the group in the West Indies have apparently not been extensive, and it is possible that *D. similis* may be found in Cuba, where Sturtevant (1921) states that it was not uncommon around fallen fruit.

HYBRIDIZATION WITHIN THE CARDINI GROUP

Streisinger (1946) studied the crossing relationships within the group using the three species: *D. polymorpha*, *D. neocardini* and *D. cardinoides*. When interspecific matings of both reciprocal types and in all three combinations were made, he found insemination of females had occurred only in crosses between *D. cardinoides* and *D. polymorpha*, and even there no viable hybrids were produced.

With the discovery of the two new species described in this paper, and the availability of strains of *D. cardini*, it was felt that further tests of hybridization within the group would be worthwhile. These tests were carried out by placing equal numbers of 1- to 3-day-old males and females in vials, changing the food every second day, and following the pairs for thirty days. Since the adults were kept on such fresh food, there was very little accidental loss during the test period. The vials from which the adults had been transferred were examined daily for four consecutive days in order to detect the presence of dead embryos or larvae. Embryos which completed part of their development and died prior to hatching were detected by their brown color. When larvae appeared in any of the vials, if the food surface was felt to be unfavorable because of bacteria or molds, the larvae were transferred to fresh food, and in certain classes of hybrids it was found that such transfers permitted development to proceed to completion. At the end of the tests the females were dissected and the sperm receptacles examined for the presence of sperm. The results are summarized in Table I and in Fig. 3. In the table tests using strains from the same general locality are lumped. The strain of *D. polymorpha* used in these crosses was homozygous for the dark abdominal pattern gene. In *D. polymorpha* the dark and light pattern depend on a single pair of genes, with incomplete dominance (Cunha, 1949).

It will be noted that in only one category of crosses, those employing *D. neocardini* as females, was there any indication of complete sexual isolation. In the crosses between *D. cardinoides* and *D. polymorpha*

TABLE I

SUMMARY OF INTERSPECIFIC CROSSES

Females	Males	Number of Pairs	Insem. Females	Sperm	Hybrids
D. cardinoides					
Brazil	*D. cardini*, Florida	24	0/23	.....	none
Guatemala	*D. cardini*, Florida	24	0/22	.....	none
Brazil	*D. acutilabella*, Florida	12	0/11	.....	none
Brazil	*D. parthenogenetica*	6	0/6	.....	none
Guatemala	*D. parthenogenetica*	12	5/12	*, s	none
Guatemala	*D. neocardini*, Brazil	18	0/16	.....	none
Guatemala	*D. polymorpha*, Brazil	18	15/17	*, s	d. e.
D. cardini					
Florida	*D. cardinoides*, Guatemala	6	0/6	.....	none
Florida-Cuba	*D. cardinoides*, Brazil	28	0/27	.....	none
Florida-Cuba	*D. acutilabella*, Florida	97	78/88	s, v	1 ♀
Florida-Cuba	*D. neocardini*, Brazil	36	32/33	s	d. e.
Mexico	*D. neocardini*, Brazil	36	23/34	.....	d. e.
Florida-Cuba	*D. polymorpha*, Brazil	72	61/64	*, s	5 ♂♂
Florida-Cuba	*D. parthenogenetica*	24	19/21	s	d. e. y.
Mexico	*D. parthenogenetica*	12	8/11	s, v	d. e. y.
D. acutilabella					
Florida	*D. cardinoides*, Guatemala	54	44/47	s, v	224 ♀♀, 2 ♂♂
Florida	*D. cardinoides*, Brazil	6	4/5	s, v	1 ♀
Florida	*D. cardini*, Florida	90	36/59	*, s	4 ♂♂
Florida	*D. parthenogenetica*	30	24/27	s	19 ♀♀
Florida	*D. polymorpha*, Brazil	72	59/62	s, v	20♀♀, 1 ♂
Florida	*D. neocardini*, Brazil	24	20/21	s	d. e.
D. neocardini					
Brazil	*D. cardinoides*, Guatemala	12	0/12	.....	none
Brazil	*D. cardini*, Florida	54	0/48	.....	none
Brazil	*D. acutilabella*, Florida	18	0/17	.....	none
Brazil	*D. parthenogenetica*	18	0/18	.....	none
Brazil	*D. polymorpha*, Brazil	24	0/22	.....	none
D. polymorpha					
Brazil	*D. cardinoides*, Guatemala	36	29/32	*, s	d. e.
Brazil	*D. cardini*, Florida-Cuba	66	49/55	s	d. e. l.
Brazil	*D. acutilabella*, Florida	30	25/27	s	d. e.
Brazil	*D. parthenogenetica*	42	32/39	s	d. e. l.
Brazil	*D. neocardini*, Brazil	48	1/44	s	none

*—Sperm grossly abnormal; s, sperm found in spermathecae; v, sperm found in ventral receptacles; d.e., death in eggs; d. e. l., death in eggs and larvae; d. e. y., death in eggs and young larvae.

(where Streisinger found insemination occurring very rarely), insemination by the end of the test period was the rule in these tests. The data agree very well with those of Streisinger in indicating a very high sexual

isolation between *D. neocardini* and the two species *D. cardinoides* and *D. polymorpha*.

Of the 19 crosses which actually resulted in insemination of the females, two showed no detectable production of hybrids, ten showed development of hybrids which died as embryos or young larvae, and the remaining seven resulted in the production of adult hybrid progeny.

The appearance of the sperm found in the spermathecae of the females was strikingly abnormal in a number of the crosses (marked by an asterisk in the table). In these cases, although occasional females were found in which the sperm appeared normal, in others it was thick, ropy and nonmotile. Since in all such individuals sperm was found only in the spermathecae, the ventral receptacle being empty, this may indicate that the sperm stored in the ventral receptacle was used up normally, and that stored in the spermathecae underwent degeneration.

The crosses carried out using *D. parthenogenetica* females and males of the other five species are not reported in the table. In every case a number of fertile female progeny were produced which were clearly impaternates rather than hybrids, as judged by their metaphase chromosomes, or their morphology and their breeding behavior. No clearly hybrid individuals have been obtained from *D. parthenogenetica* females.

Since in all the species included here some parthenogenesis has been observed, (with death prior to hatching in all species except *D. parthenogenetica* and *D. polymorpha*), the question arises as to whether or not the observed inviable embryos and young larvae produced in some of the crosses were indeed hybrids, or were simply impaternates. although the frequency of such inviable embryos was much higher in the crosses listed, than when virgin females are allowed to produce eggs in the absence of males, the possibility exists that insemination of a female might increase the rate of parthenogenesis. In the crosses listed this possibility could not be ruled out, although it seems improbable since tests using mated and unmated *D. parthenogenetica* females have indicated that mating with fertile conspecific males, or prolonged association with males of closely related species does not increase the rate of parthenogenesis (Stalker, unpublished).

Description of the Hybrids

D. acutilabella ♀♀ X *D. cardini* ♂♂. *Four males*, sterile when tested against females of both parental species. Bristles minute. Testes rudimentary. Genitalia intermediate, see figure 2 B.

D. acutilabella ♀♀ X *D. parthenogenetica* ♂♂. *Nineteen Sterile females*, all from homozygous light *D. acutilabella* mothers; showed very light abdominal pattern characteristic of *D. parthenogenetica*. Fore-femora showed the thick distal hairyness characteristic of *D. parthenogenetica*, but with an occasional bristle (2 femora out of 36 examined) on the distal posterodorsal surface as in *D. acutilabella*. In one female the last three abdominal tergites were only partially fused in the mid-dorsal line.

D. acutilabella ♀♀ X *D. polymorpha* ♂♂. *Twenty females*, almost completely sterile. Produced one daughter when backcrossed to *D. polymorpha* males. All hybrids developed abnormally black palpi and third antennal segments as they aged. Fore-femora with thick distal hairyness characteristic of *D. polymorpha* but with one or two bristles on the distal postero-dorsal surface, as in *D. acutilabella*. The *D. acutilabella* mothers were all homozygous light, the *D. polymorpha* fathers homozygous dark, and the hybrids showed an intermediate pattern midway between light *D. acutilabella* and dark *D. polymorpha*, and resembling the heterozygous pattern of *D. acutilabella*.

One male. Labellum intermediate, showing a short anterior horn, as in *D. acutilabella* and a very slight ventral protuberance as in *D. polymorpha*. Genitalia with second row of bristles on clasper weakly developed, anteromedial corners of anal plates without anterior process of *D. acutilabella*, but bearing two bristles intermediate in length between those of *D. acutilabella* and *D. polymorpha*. Fore-femora with thick distal hairyness of *D. polymorpha* and one distal posterodorsal bristle as in *D. acutilabella*.

D. acutilabella ♀♀ X *D. cardinoides* ♂♂. *Two hundred twenty-five females.* Fertile, but with daily egg production about one-fourth normal. Hind-gut just anterior to rectum showing typical whitish yellow of *D. acutilabella* rather than strong orange of *D. cardinoides*. Produced backcross progeny of both sexes when mated to males of either parental species. In the original crosses in which the *D. acutilabella* parents were homozygous light, the abdominal banding of the F_1 hybrids was intermediate, resembling heterozygous light in *D. acutilabella*. Where the *D. acutilabella* parent was homozygous dark the hybrid females were also dark, resembling homozygous dark *D. acutilabella*, or *D. cardinoides*.

Two males. Sterile when tested with females of both parental species. Palpi and labellum were intermediate between those of parental species, (see figs. 1 I and 2 S). Testes rudimentary. Genitalia with anterior process on anteromedial corner of anal plates, but with two moderately long straight bristles, rather than the many short straight ones of *D. cardinoides* or the single long curved one of *D. acutilabella*.

D. cardini ♀♀ X *D. acutilabella* ♂♂. *One female.* In this case, despite the fact that the *D. acutilabella* male parent was homozygous light, the abdominal patterns of the hybrid was dark, resembling the *D. cardini* mother or homozygous dark *D. acutilabella*. This female was normal in appearance, and produced many normal looking eggs but failed to mate with males of either of the parental species.

D. cardini ♀♀ X *D. polymorpha* ♂♂. *Five males.* All sterile when tested with both types of females; testes rudimentary. In their genitalia these males were *D. cardini*-like, having 2 to 3 well developed bristles at anteromedial corners of the anal plates and lacking the well developed secondary or anterior row of bristles on the clasper as in *D. polymorpha*. The labellum was intermediate, showing a weakly developed *D. polymorpha*-like ventral protuberance; the fore-femora showed the thick hairyness of *D. polymorpha* but also a single bristle on the distal posterodorsal surface, characteristic of *D. cardini*.

DISCUSSION

Taking into account the known geographical distribution, it will be seen that the six species treated above are completely isolated genetically, in that the two forms which produce fertile hybrids, *D. acutilabella* and *D. cardinoides*, are not sympatric, the former being known from Cuba and Florida, the latter unrecorded from either Florida or the West Indies. With the possible exception of the allopatric pair, *D. acutilabella* and *D. polymorpha*, (see Description of the Hybrids, above), all the other species combinations produced sterile hybrids or none at all. Thus, either complete reproductive isolation or geographic isolation obtains throughout the group. Among the isolating mechanisms, sexual or psychological isolation appears (in the laboratory) to be rather inefficient, as evidenced by the high frequency of cross insemination observed. On the other hand, inviability or sterility of the hybrids forms an effective genetic barrier in the great majority of interspecific crosses.

ACKNOWLEDGMENT

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While there, Dr. A. H. Sturtevant generously granted the use of his collection of pinned material, and also gave much aid in the way of helpful suggestions and criticisms. Many of the strains of flies used were provided by others. Drs. M. R. Wheeler, Th. Dobzhansky, C. Pavan, A. B. daCunha, P. T. Ives, J. I. Townsend and Mrs. H. H. Plough have been especially helpful in this respect.

SUMMARY

1. The taxonomic status and known geographic distribution of the North and Central American members of the *Drosophilia cardini* group is reviewed.

2. Two new species, *D. acutilabella* from Cuba and Florida and *D. parthenogenetica* from Mexico are described.

3. An illustrated key for the identification of pinned specimens is presented.

4. Hybridization tests between six of the species of the group show complete reproductive isolation in all crosses except that between the allopatric species *D. acutilabella* and *D. cardinoides*. *D. acutilabella* females when mated to *D. cardinoides* males will produce fertile hybrid females and rare sterile hybrid males. The hybrid females will produce progeny of both sexes when backcrossed to males of either parental species.

5. Where reproductive isolation occurs it depends on sexual (psychological) isolation, hybrid sterility and/or hybrid inviability.

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STUDIES ON THE EFFECT OF INSECTICIDES ON THE OVIPOSITION OF ANOPHELES QUADRIMACULATUS SAY[1]

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INTRODUCTION

Studies of the factors stimulating oviposition by arthropods may lay the foundation for additional fundamental knowledge of the action of insecticides. It has been shown (DeCoursey and Webster 1952) that exposure of adult female *Aedes sollicitans* (Walker) to certain irritants and insecticides did not markedly impair their egg-laying ability These insects laid their eggs just prior to death. The concept of "death with oviposition" or a "death stress" implied that anything that killed the mosquito—short of crushing it—would cause oviposition. This was hypothesized to be a survival phenomenon. It was further hypothesized that oviposition under the influence of certain agents may indicate why insecticides are not always completely effective. The percentage of viable eggs produced while under the influence of insecticides was relatively high and a portion of the eggs hatched under laboratory conditions. DeCoursey and Webster (1952) suggested that there are three main courses by which insecticides act effectively: (1) immediate kill, males and females, (2) persistent residual action affecting adults and subsequent hatch, and (3) oviposition under the insecticidal stress in unfavorable conditions for viability and hatch. If this is true it is possible that under favorable conditions for hatch and development, oviposition following treatment by insecticides may result in viable eggs and a completion of the life cycle.

The purpose of the present study was to determine whether the theory of "death with oviposition" would hold true for *Anopheles quadrimaculatus* Say, a mosquito belonging to a different genus than the one previously studied, and which has different habits of oviposition.

MATERIALS

The laboratory strain of *Anopheles quadrimaculatus* was obtained through the courtesy of the Orlando (Florida) Laboratory of the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture

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This work is not to be construed as necessarily reflecting the views of the Department of the Navy.

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and subsequently reared through many generations. The newly hatched larvae were fed on brewers' yeast and brain heart infusion and subsequently on finely ground commercial dog food. The adults were fed approximately five per cent sugar water, undiluted honey, and beginning at the age of three to five days, daily blood meals from a guinea pig. Four to six days after their initial blood meal the insects were treated with the following insecticides: DDT, chlordane, aldrin, toxaphene, benzene hexachloride (gamma isomer), and rotenone.

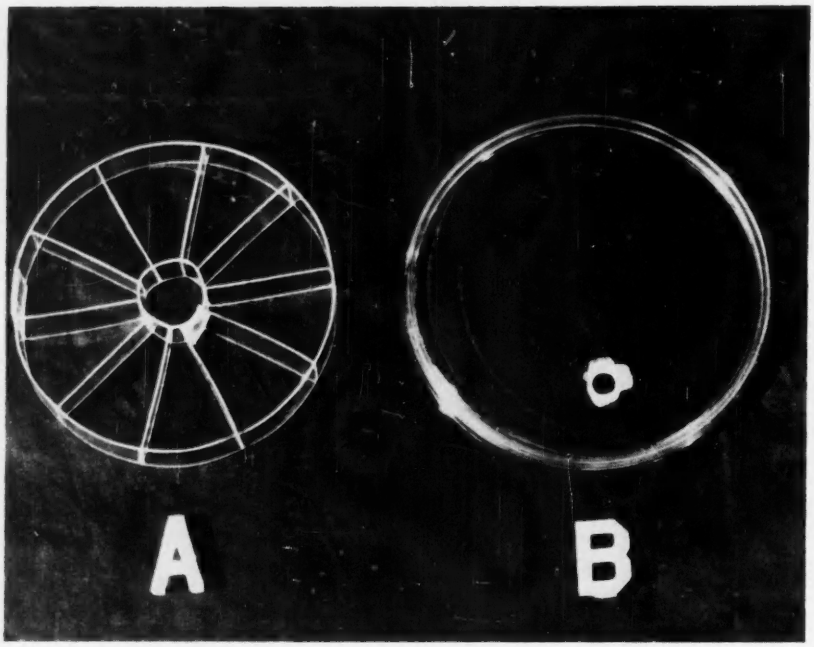

FIG. 1. A. Cellulose acetate sections used in Petri dish.
B. Petri dish lid with hole for the introduction of insects.

PROCEDURE

The insecticides were used in powder form, diluted with talc. The various powders were placed in separate 50 ml. flasks which were rotated by hand until a thin coating of the powder covered the inner surface. Excess powder was then removed by inverting the flasks and tapping them on a hard surface. Ten mosquitoes at a time (thirty for hatching tests) were then placed in one of the insecticide-coated flasks, and the flask rotated by hand for sixty seconds. The same procedure was followed for the controls of which a part were untreated and a part treated with talc alone. The mosquitoes were removed by inverting the coated container over a clean 50 ml. flask. From this flask individual insects were transferred to a previously compartmented Petri dish (fig. 1, A and B). The dish contained either wet or dry filter

paper as required. On top of the filter paper cellulose acetate partitions were placed dividing the dish into ten sections. A quarter inch opening was drilled in the Petri dish lid as an entrance for the insects. The flask containing the mosquitoes was inverted over the lid and as one insect entered a section through the opening, the lid and flask were rotated until the opening led into another section. At the end of a definite time interval, the eggs deposited in the individual sections of the dish were counted and tabulated for each insect and each agent.

In tests for forced laying, ten *Anopheles* adults were placed in each of six cylindrical copper-screen cages 1¼ inches in diameter by 1⅛ inches in height. Each cage was sprayed from a distance of six inches with a bulb atomizer, and received only the minute amount expressed by a single compression of the bulb. Three of the cages were sprayed with two percent chlordane in refined kerosene, and three with distilled

TABLE I

EFFECT OF INSECTICIDES ON OVIPOSITION ON WET FILTER PAPERS

Insecticide	Percent of Females Ovipositing	Number of Eggs	Mean Eggs per Female	Standard Deviation
DDT, 5%	50	408	16	±26
BHC, 0.2%	38	465	24	23
Rotenone, 2–3%	42	577	27	29
Chlordane, 2%	40	745	37	54
Toxaphene, 0.25%	54	1036	38	51
Talc control	26	509	39	43
Untreat. control	60	549	46	59
Aldrin, 0.25%	30	794	53	64

water as controls. The cages were then placed on separate sheets of ruled black paper. At the end of fifteen minutes each cage was shifted to another sheet of paper. The eggs on the original papers were then counted. This procedure was repeated every fifteen minutes for five hours for both the treated and the controls.

The data on egg hatch following treatment of adults with the various insecticides were obtained by placing the adults in separate Stender dishes half filled with distilled water. It was necessary to make a separate run to determine the percentage that would hatch, because the eggs deposited on dry filter paper remained white and shriveled, and those on wet filter paper partially darkened, but were shriveled after 24 hours when the last oviposition count was made. The Stender dishes were placed in a constant temperature chamber at 78° F., and the larvae from the subsequent hatch were transferred to rearing pans with pipettes and wire loops.

EFFECT OF INSECTICIDES ON OVIPOSITION

Anopheles quadrimaculatus under laboratory conditions will lay sufficient eggs in 24 hours for comparative studies. The effect of insecticides on oviposition was compared, therefore, with the untreated controls 24 hours following the exposure of the females. Table I shows

the mean number of eggs obtained on wet filter paper in 24 hours from each female that laid, for each insecticide, and for the controls.

Standard percentages of insecticides were used and all insects were given a 60 second exposure. A total of 370 female mosquitoes was used, 50 in each group, except for the untreated control group which contained 20. Thirty to 54 percent of the females oviposited under the influence of the various insecticides, while 26 percent of the talc controls and 60 percent of the untreated controls oviposited. With reference to the mean number of eggs from each female, none was significantly greater or less than the controls. Analysis five hours after treatment also indicated that there was no significant difference under wet conditions.

CONCEPT OF "FORCED LAYING"

In the previous paper it was stated that *Aedes sollicitans* when treated with insecticides, yielded data which indicated that oviposition might take place under dry conditions when oviposition should normally

TABLE II

EFFECT OF INSECTICIDES ON OVIPOSITION ON DRY FILTER PAPER

Insecticide	Percent of Females Ovipositing	Number of Eggs	Mean Eggs per Female	Standard Deviation
Untreat. control	10	20	10	± 9
Aldrin, 0.25%	30	228	38	50
Talc control	35	178	25	18
BHC, 0.2%	35	48	7	7
Rotenone, 2–3%	35	86	12	11
DDT, 5%	35	176	25	24
Toxaphene, 0.25%	45	350	39	37
Chlordane, 2%	50	716	72	54

not occur. This seemed to substantiate the concept of "forced laying". Similar tests were made with *A. quadrimaculatus* under dry conditions and at a reduced time, five hours, which would not be conducive to oviposition. One hundred fifty adult females were used with sixty seconds' exposure as in the previous test. Following exposure they were placed in individual sections in a Petri dish over dry filter paper. The results are shown in Table II.

The percentages of females ovipositing after treatment with chlordane and toxaphene are significantly higher statistically than that of the untreated control at the 2 percent level. There has been some indication that talc in the control increases oviposition to some extent, as in this case the percentage that laid when treated with talc was 35, whereas the untreated control was 10. However, this was not statistically significant. With respect to the mean number of eggs per female that laid, chlordane is significantly higher than both the untreated or the talc control at the 4 percent and 2 percent levels of probability respectively. Benzene hexachloride is significantly lower than the talc control at the 2 percent level.

Since treatment with chlordane yielded the greatest percentage of females that laid, the number of eggs per female sprayed with 2 percent chlordane in oil was compared with the number per female sprayed with distilled water. Using ten females per cage, three cages were sprayed with chlordane and oil, and three with distilled water. The rate of oviposition was determined each fifteen minutes for five hours as described in "Procedure" above, then a final count was made at 24 hours. The results are shown in Table III. Note that no change occurred from two to five hours.

Sixty-seven percent of the total eggs laid in 24 hours following treatment with chlordane were laid in the first fifteen minutes while 93.5 percent were laid in the first half hour. The controls laid 40 percent of the total during the first 15 minutes and 63 percent during the first half hour. These data further support the concept of "forced laying."

TABLE III

OVIPOSITION FOLLOWING CHLORDANE-OIL SPRAY

TREATED-CHLORDANE 2%			CONTROL-DISTILLED WATER	
Time in Minutes	Total Number Eggs	Mean Eggs per Female	Total Number Eggs	Mean Eggs per Female
15	1494	49.8	67	2.2
30	2082	69.4	105	3.5
45	2192	73.1	116	3.9
60	2214	73.8	117	3.9
75	2218	73.9	138	4.6
90	2224	74.1	151	5.0
105	2226	74.2	151	5.0
120	2226	74.2	152	5.1
300	2226	74.2	152	5.1
24 hours	2226	74.2	166	5.5

EFFECT OF INSECTICIDES ON HATCH AND DEVELOPMENT

The percentage of eggs that hatched after oviposition by females treated with the various insecticides was determined for the females that laid (10 to 17) in each group. The data are given in Table IV.

The mean percent hatch of the eggs from treated mosquitoes varied from 24 to 88 while that of the talc control and the untreated control was 68 and 83 respectively. The larvae produced from 8 to 58 percent pupae compared with 29 percent for the talc controls and 40 percent for the untreated controls. In the treated group from 86 to 97 percent emerged as adults compared with 94 percent for the untreated controls and 97 percent for the talc controls. These data indicate that under laboratory conditions at least, the eggs from adult *Anopheles quadrimaculatus* exposed to certain insecticides are viable, many hatch, and the larvae are capable of maturing, pupating and producing adults.

These adults have mated, oviposited normally, and produced a second generation of adults which were apparently normal.

EFFECT OF MECHANICAL STRESS ON OVIPOSITION

It has been shown in the case of *Aedes sollicitans* a "death stress" was induced by purely mechanical means. When the head of the mosquito was crushed or severed from the body with a razor blade oviposition started immediately and continued for many hours. In the case of *Anopheles quadrimaculatus*, 50 females with their heads severed, and 50 with their heads crushed were placed on water, and no eggs were produced in 24 hours, although a few without heads were still alive at that time. In the controls, on the other hand, 17 out of 25 oviposited in 24 hours, or 68 percent. These insects were insectary-reared, whereas the *Aedes sollicitans* were caught in the wild state. Also the experiments on *Anopheles* were conducted in the winter, while work on *Aedes* was conducted in the summer, a difference of six months. It is possible that these variants may account for the differences in reaction to mechanical stress.

TABLE IV

OVIPOSITION,* HATCH AND POST-EMBRYONIC DEVELOPMENT (91 FEMALES)

Insecticide	Total Number Eggs	Mean Percent Hatch	Percent Larvae Pupated	Percent Adults from Pupae
Rotenone	490	24	68	97
BHC	359	24	30	91
DDT	247	47	38	86
Chlordane	987	60	33	94
Aldrin	1061	60	8	92
Talc control	1310	68	29	97
Untreat. control	1447	83	40	94
Toxaphene	1302	88	42	96

*During a 24-hour period.

CONCLUSIONS

Anopheles quadrimaculatus treated with certain insecticides, diluted in powder form, oviposited before death. Under certain experimental conditions (24 hours on wet filter paper) both treated and control insects oviposited approximately the same number of eggs compared statistically. In five hours on dry filter paper, conditions which would not be expected to favor oviposition, chlordane produced a significantly greater number of eggs than the untreated control. Benzene hexachloride under similar tests led to a significantly smaller number of eggs per female than the untreated control. No attempt was made to vary the exposure time to produce a "death stress" without mortality. A shorter exposure time might have given a greater percentage ovipositing, but for consistency, 60 seconds was used throughout. Also, a lower concentration of insecticide might have given a higher percentage ovipositing, but again, for consistency, the usual concentrations of

insecticides were used. Forced laying was demonstrated by spraying mosquitoes with two percent chlordane in oil.

Tests for completion of the reproductive cycle proved that starting with eggs deposited on water by mosquitoes treated with powdered insecticide, adults would develop and further generations be produced in all cases.

Mechanical stimulation *i.e.*, heads crushed or severed from the body, did not induce oviposition in this species under the experimental conditions.

Therefore, for *Anopheles quadrimaculatus* it has been shown that under favorable conditions for hatch and development oviposition following treatment by insecticides will result in viable eggs which may produce apparently normal adults.

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APHIDS OF THE ROCKY MOUNTAIN REGION, by MIRIAM A. PALMER. Pp. 452, 455 figs., 8 plates. Thomas Say Foundation. 1952. Price $10.25.

"Including primarily Colorado and Utah, but also a bordering area composed of southern Wyoming, southeastern Idaho and northern Mexico.

"The aphids in this region include most of the economic species known to occur in the United States or even North America."

Professor Miriam Augusta Palmer, retired Assistant Professor of Entomology and Insect Delineator of the Colorado Agricultural Experiment Station and the Colorado Agricultural and Mechanical College, Fort Collins, has been drawing, collecting, and investigating aphids in the Rocky Mountain Region since 1904, first as an assistant to the pioneer aphidologist, the late Professor C. P. Gillette, whose works have received international recognition, and later in her own right following in his footsteps and worthily succeeding and even exceeding him.

This latest work on American aphids includes keys to species of plant lice commonly infesting economic plants in the region grouped under their respective hosts; a general host plant list; complete bibliography; a gazetteer of localities mentioned which do not have post offices; and an index to genera and some 460 species.

Of special note are: the use of the family name Aphidae for the more cumbersome Aphididae; the judicious division into subfamilies, tribes, subtribes, genera, and species; the aid in recognizing each species by its chief distinguishing characters.

For nearly every species the author has also furnished the common and scientific name; important references; synonymy; a detailed drawing of the most important characters with measurements; a description of various forms; list of host plants; dates of collection; and distribution.

There are also 8 colored plates reproduced partly from earlier papers.

The book is well printed on what appears to be a very durable quality of paper and is bound in blue buckram with gilt lettering. As a co-worker in the same field I look upon this work as an excellent piece of research and composition which has required years of tedious labor and skillful artistry as well as much forceful strength, courage, and determination.

In view of its real value and serviceability I am much more inclined and enthusiastic to look upon all of its admirable qualities than to try to seek out any possible flaws in composition, arrangement, completeness or printing. It is a most excellent and useful compendium and should be in the hands of every entomologist and in the libraries of all biological and agricultural departments everywhere.—E. O. ESSIG.

ON THE HEART IN RELATION TO CIRCULATION OF HEMOCYTES IN INSECTS

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Verson (1908) found that silkworm hemocytes did not enter the heart, and stated that this was because of the narrowness of the ostial slits. Absence of hemocytes from the silkworm heart was noted by Masera (1933) in his study on pulsation rates. According to Weber (1935) the hemocytes of adult *Aleurodes* are too large to enter the heart and only plasma circulates through it. Wigglesworth (1950) found that the hemocytes in *Rhodnius* fail to enter the heart lumen and on the basis of this observation and those of the previously mentioned workers has concluded that in insects " . . . only cell-free hemolymph can be said to truly circulate." He goes on to say that " . . . it is obvious, therefore, that the numbers of circulating cells must vary enormously from time to time."

A number of workers have found hemocytes absent from the hearts of other insects (Wagner, 1835; Tzonis, 1936; Chauvin, 1941; and Buck and Keister, 1950) but offered no explanation of it. Verloven (1847) observed that hemocytes were either absent from the heart or circulated less numerously in it than in the hemocoele proper. He noted that the hemocytes stopped near the terminal end of the dorsal vessel and thought they accumulated to form fat body in some species. Verloven believed that the dorsal diaphragm was capable of excluding hemocytes from the heart.

On the other hand, many authors have observed hemocytes within the hearts of insects. Bowerbank (1833) illustrated "oat-shaped" corpuscles in the heart of an "Ephemera" larva. Hemocytes were observed entering and leaving the heart of *Corethra plumicornis* larvae by Dogiel (1877); however, Tzonis (1936) did not confirm this. Miall and Hammond (1900) observed hemocytes entering the heart of *Chironomus* larvae (p. 73). Hemocytes were shown within the hearts of *Apis mellifera* larvae by Nelson (1924), and Eastham (1929) illustrated hemocytes in the heart of *Phaenoserphus* larvae. Hemocytes were found within the heart of 96-hour old embryos of *Diacrisia* by Johannsen (1929). Sharif (1937) reported that hemocytes were present in the heart of the rat flea larva. Nutting (1951) frequently mentioned the presence of hemocytes flowing out of the heart and through the phagocytic organs in a number of Orthoptera.

The aim of this study was to determine whether hemocytes were excluded from the hearts of a number of other insects and to examine the question of whether hemocyte exclusion from the heart could account for wide normal variations in total hemocyte counts.

MATERIALS AND METHODS

1. *Fixed material.*—The following species were fixed in neutral 10% formalin or in hot alcoholic Bouin, embedded in paraffin, sectioned transversely and horizontally at 6 microns, and stained with Delafield's hematoxylin and eosin or with Giemsa:

Order	Species examined	Stages used
Blattaria	*Periplaneta americana* (L.)	adults
Orthoptera	*Melanoplus* sp.[1]	nymph
Hemiptera	*Cimex lectularius* L.	adults
Anopleura	*Pediculus humanus corporis* DeGeer	adults
Coleoptera	*Tenebrio molitor* L.	larvae, pupae, adults
Lepidoptera	*Galleria mellonella* L.	larvae, pupae
	Heterocampa manteo Dbldy.[1]	larva
	Pieris sp.[1]	larva
Hymenoptera	*Apis mellifera* L.	larvae, pupae, workers
Diptera	*Culex pipiens* L.	larvae, pupae
	Aedes aegypti (L.)	larvae, pupae
	Anopheles quadrimaculatus Say	larvae, pupae, adults
	Chironomus sp.	larvae
	Drosophila melanogaster Meigen	larvae, pupae, adults
	Phormia regina Meigen	larvae, pupae, adults
	Sarcophaga bullata Parker	larvae, pupae, adults

2. *Living material.*—Because of their relative transparency, young living larvae of *Phormia regina*, *Drosophila melanogaster*, *Sarcophaga bullata*, and *Sciara coprophila* were placed between slide and coverslip for examination of the heart and the hemocytes at 180 to 1455 diameters.

Young *Rhodnius prolixus* nymphs and *Cimex lectularis* adults were examined under coverslips in microslides at 240 diameters. Young nymphal *Blatella germanica* were sealed in microslides with ringed coverslips and their hearts examined at 180 diameters.

RESULTS

Generally many free hemocytes were found in both the hemocoel and in the heart lumen in representative sections from *Periplaneta americana*, *Tenebrio molitor*, *Galleria mellonella*, *Heterocampa manteo*, *Pieris* sp., and *Apis mellifera*. However, some specimens showed no hemocytes within the heart. It may be that in such fixed material hemocytes were pumped out of the heart tube at the time of fixation. It is also possible that hemocytes could fall out of paraffin sectioned material during sectioning or subsequently. Very few hemocytes were observed in sections of a *Melanoplus* nymph but some were seen free in the hemocoel and within the heart lumen. Fixed material is far less reliable than examinations of living specimens. For example, in *Cimex* hemocytes were only rarely found in the hearts of fixed adults but were observed to enter and circulate through the hearts of living

[1]Sectioned material of these insects was supplied through the courtesy of Dr. A. Glenn Richards, University of Minnesota.

specimens. *Cimex* hemocytes are all round or ovoid cells in the living animal, as can be seen especially well when these cells circulate through the legs.

In young nymphs of *B. germanica* numerous spindle-shaped hemocytes were observed streaming into all ostial valves(both thoracic and abdominal) of the rapidly pulsating hearts (ca. 120 beats/min.) (Plate I, figure 1). These hemocytes were observed being shot both backward and forward through the lumen of the heart as it reversed direction in beats. Arteries were observed in the thoracic part of the heart but were not seen in the abdominal part. Hemocytes streamed in great numbers up along intersegmental, fat-body-lined lacunae into the valves.

The hearts in young living *Rhodnius prolixus* nymphs were so faintly visible through the cuticle that it was not possible to study the question of whether hemocytes were capable of entering their slowly beating hearts (ca. 30 beats/min.). In a nymph in which both heart and gut had clearly ceased moving, it was observed that the femorotibial pulsatile membrane was beating regularly (44 to 56 beats/min.) and maintaining an excellent circulation of mostly spindle-shaped hemocytes within the legs (Plate I, figure 4). This observation is of particular interest, for it shows that circulation can be maintained in certain portions of the hemocoel even though the heart has stopped.

Young living *Phormia regina* have numerous, free, round, and spindle-shaped hemocytes circulating in the hemocoel, but none of them were seen to enter the "ventricular" portion of the heart (posterior trunk of Pantel, 1914) (Plate I, figure 2). Hemocytes circulate haphazardly within the hemocoel, being slushed backwards and forwards with telescopic body movements, or from side to side, in and out among the heaving viscera. Hemocytes appear to circulate principally (most extensively) in the perivisceral cavity, but some of them come up into the dorsal sinus and then slip under or around the heart yet do not seem to enter it. Hemocytes within the dorsal sinus are moved about by currents set up by the movements of the heart. When hemocytes pass under the ventricular part of the heart it is difficult to be certain whether they have actually entered it or not. Hemocytes do not normally enter the "aortic" part of the heart (intermediate trunk of Pantel).

Sometimes coverslip pressure caused hemocytes rapidly to clump together, and such clumps frequently circulated within the hemocoel. Prolonged coverslip pressure brought about a marked qualitative decrease in total numbers of circulating cells. Most of the hemocytes could be seen lying singly or in clumps on the hypodermis and other tissues. Hemocytes were also observed to undergo so-called "passive" to "active" transformations *in vivo*.

Drosophila melanogaster larvae have much fewer circulating hemocytes than *Phormia* larvae. Very few hemocytes were actually seen to enter the heart. For the most part, hemocytes were frequently seen to approach ostial valves, "hesitate" for a moment, and then be swept away by hind-gut movements. Mostly hemocytes circulate elsewhere in the body cavity for only short distances. Perhaps this is due to coverslip pressure. Clumps of variable numbers of sessile hemocytes were often seen especially around the base of the heart.

No spindle-shaped hemocytes were observed in the living larvae. In fixed material, hemocytes were only rarely found in the heart lumen.

Observations similar to those made on *Drosophila* were made on young living *Sarcophaga bullata* larvae, but in these no posterior accumulations of hemocytes were found.

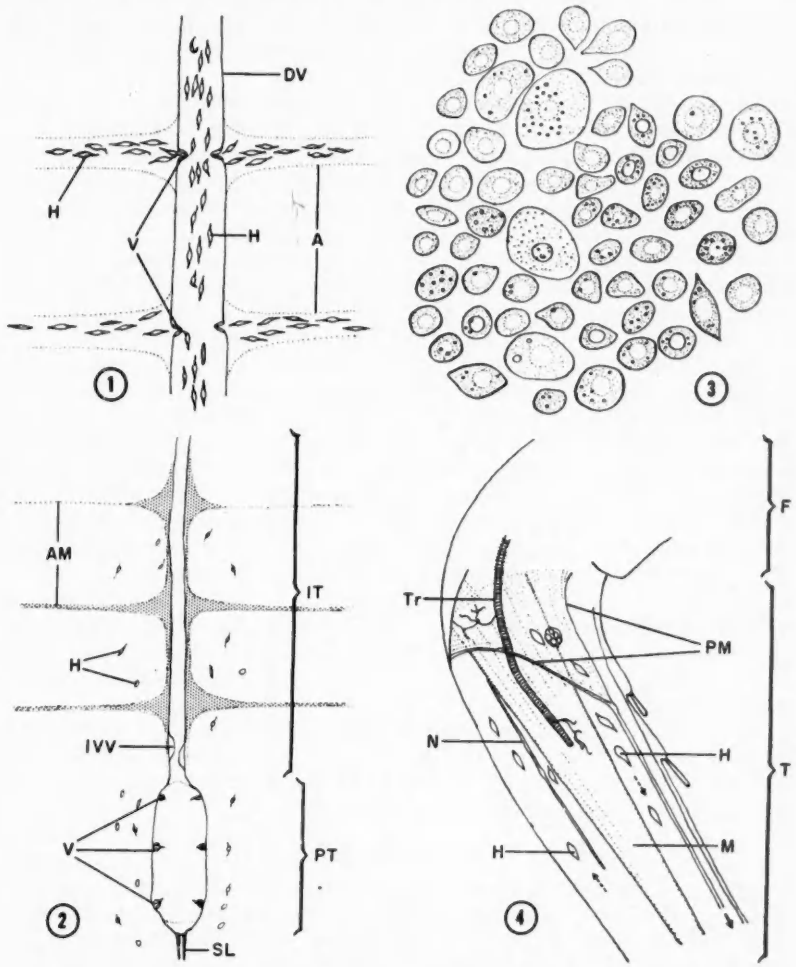

FIG. 1. Portion of dorsal blood vessel (DV) in young *Blatella germanica* nymph showing hemocytes (H) within the heart lumen and in the arteries (A). Ostial valves are shown at V. FIG. 2. Portion of the heart of young *Phormia regina* larva showing the "posterior trunk" (PT), the intermediate trunk (IT), ostial valves (V), interventricular pads (IVV), alary muscles (AM), and hemocytes (H). FIG. 3. Appearance of living sessile hemocytes in the posterior accumulation at the base of the heart of a young *Sciara coprophila* larva. FIG. 4. Portion of the pulsatile organ (PM) in a young *Rhodnius prolixus* nymph between the femur (F) and the tibia (T). Note the large trachea (Tr), a possible nerve (N). The membranous organ is pulled in the direction of the solid arrow. Hemocytes (H) circulate in the leg as indicated by the dotted arrows.

In *Sciara coprophila* large accumulations of sessile hemocytes were observed dorsal and lateral to the terminal heart chamber (Plate I, figure 3). Sessile hemocytes varied in size, shape, and possession of intracytoplasmic granules. Granules in intact cells were observed to undergo Brownian movements.

Generally either extremely few or no *free* hemocytes were found in the hemocoel or heart of most fixed specimens of *Culex pipiens*, *Aedes aegypti*, *Anopheles quadrimaculatus*, *Chironomus* spp., and *Pediculus humanus corporis*.

Living *Aedes*, *Anopheles*, and *Culex* larvae were examined in a small film of water with and without coverslips at 180 to 360 diameters. None of the *Aedes* larvae examined had any free hemocytes whatsoever. Living *Anopheles* larvae possessed extremely few round and spindle-shaped hemocytes which either did not circulate or else circulated for very short distances in the hemocoele. Most of their hemocytes lay against the epidermis singly or in small groups. Sometimes when *Anopheles* larvae were held under coverslip pressure oil droplets and hemocytes were set free and these were capable of being sucked into the heart and circulating through it. Ten living *Culex* larvae were examined and variable numbers of free hemocytes were seen in the perivisceral sinus. These hemocytes were round or ovoid cells. Some of these free cells were capable of entering and circulating through the rapidly beating heart (*ca.* 110–140 beats/min.). A maximum of 6 hemocytes were observed to enter and be circulated through the heart of one *Culex* larva in a one-minute observation period. In this insect 18 cells circulated around and underneath the heart in an equivalent observation period. In most cases, however, no hemocytes entered the heart even though free cells were present in the hemocoele. It was observed that the free hemocytes of *Culex* larvae moved in a more or less definite route: caudad in the ventral part of the perivisceral sinus and cephalad in the dorsal part of the sinus. Besides free hemocytes the hemolymph also contained suspended oil droplets and very fine granules.

In most of the insects studied, ostial openings were considerably larger than any of the hemocytes. In none of the specimens examined was any special hemocyte-filtering device found that could easily account for exclusion of cells from the heart.

DISCUSSION

Although hemocyte circulation in *Phormia* larvae is largely restricted to the perivisceral sinus, hemocytes nevertheless come into the dorsal sinus and fail to enter the heart. The explanation of this phenomenon is obscure for the ostial valves do not appear capable of restraining them. Perhaps, the force necessary for propelling hemocytes through the slit-like valves is insufficient. The failure of hemocytes to enter the *Phormia* heart, however, would not affect total hemocyte counts unless it were possible to withdraw hemolymph only from the heart lumen.

Although Verson (1908) and Masera (1933) believed that ostial slits were too small to admit hemocytes, Gerould (1938) stated that these openings were wider than the hemocytes (p. 340). He considered

the mechanism of hemocyte exclusion from the heart, reported by Verson, to be unknown, but did not study in what way hemocytes were excluded (Gerould, personal communication). One might well expect an absence of hemocytes in the heart of silkworm pupae, for Gerould has shown (1929, p. 470) that it may characteristically cease beating for more than an hour, or beat feebly for long periods.

Poisson and Pesson (1938) found in the coccid, *Icerya*, a peripheral "blood cavity" in which free hemocytes occurred and a membrane-enclosed "visceral cavity" (sac) which excluded all but a few small hemocytes from the heart lumen. They reported that the heart was situated in the visceral cavity and stated that only plasma circulates in this insect. The authors present no evidence to show that hemocytes in the "blood cavity" actually fail to circulate. It seems unlikely that currents in the blood cavity would not bring about circulation of free cells.

Coon (1944) in his study on pyrethrum-poisoned cockroaches observed that "the rate of blood circulation was fairly well correlated with rate of heart beat . . . ," but he noted that "circulation ceased before the heart stopped beating."

Many complex physiological and pathological conditions are associated with marked changes in the numbers of circulating hemocytes in insects, but the failure of free hemocytes to enter the heart and be circulated through it (as is the case in *Phormia* larvae) obviously cannot be considered a factor accounting for the great variations known to occur in total hemocyte counts, unless such counts are made from hemolymph withdrawn exclusively from the heart lumen.

SUMMARY

1. Abundant free hemocytes generally occur in both the heart lumen and hemocoel of fixed and sectioned *Periplaneta americana*, *Tenebrio molitor*, *Galleria mellonella*, *Heterocampa manteo*, *Pieris* sp., and *Apis mellifera*.

2. Numerous free hemocytes enter the heart in *Blatella germanica* as can be seen by examination of living specimens.

3. Free hemocytes are capable of entering the hearts of living *Cimex lectularius* although relatively few of them do so.

4. The cuticle of living *Rhodnius prolixus* nymphs was too opaque to permit observations on the question of whether hemocytes are capable of entering their hearts. In one case it was observed that in a nymph in which both heart and gut had ceased moving, the femorotibial pulsatile membrane maintained excellent circulation of free hemocytes within the legs.

5. Many hemocytes are free in the hemocoel of young *Phormia* larvae but fail to enter the heart lumen. *Phormia* hemocytes are circulated haphazardly, principally in the perivisceral cavity, by telescopic body movements and by movements of the alimentary canal.

6. Free hemocytes are relatively scarce in both *Drosophila melanogaster* and *Sciara coprophila* and only very rarely entered the heart lumen. Posterior accumulations of sessile hemocytes were observed dorsal and lateral to the terminal heart chambers of *Drosophila* and *Sciara* larvae.

7. Either very few or no *free* hemocytes were seen in fixed specimens of *Culex pipiens*, *Aedes aegypti*, *Anopheles quadrimaculatus*, *Chironomus* spp., or *Pediculus humanus corporis*. Examinations of living *Aedes* larvae showed no free hemocytes. Very few free hemocytes were seen in living *Anopheles* larvae but these were capable of circulating through the heart. Free hemocytes circulate in the perivisceral sinus of *Culex* larvae but relatively few of these enter the heart.

8. Failure of hemocytes to enter the heart and to be circulated through it cannot be considered as a factor accounting for wide normal variations in total hemocyte counts, unless hemolymph is withdrawn exclusively from the heart lumen.

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NOTES ON THE PHLEBOTOMUS OF PANAMA
(Diptera, Psychodidae)

XI. The Male of *P. cruciatus* Coq. and Notes on Related Species[1]

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In 1948 we discussed the status of *Phlebotomus cruciatus* on the basis of the female, the only sex known with certainty at that time. Since then much additional material has been secured, including what we believe are males of this species. Recently Floch and Abonnenc (1950) have questioned our revalidation of *cruciatus*, so that it was felt necessary to go over carefully the basis of our action, including a re-examination of the type material in the U. S. National Museum.

On reading over our remarks of 1948, it appears that we did not make ourselves entirely clear on several points. The original description of the species by Coquillett (1907) states: "Five females. Type No. 10,155 in the U.S.N.M." A re-examination of this material by one of us (M.H.) in Dec. 1951 and Jan. 1952, shows the following situation. There are five, and only five, specimens of this species in the collection. Four are mounted on slides, the remaining one, of which only three legs remain, is pinned. The specimens are labelled as follows:

Slide A. This bears five small printed labels, showing pin-holes, glued to the left-hand side of the slide, as follows: "Biting/Apr. 15 1906/ Cacao Trece Aguas," "Alta V. Paz/Guatemala," "Schwarz and Barber coll.," "Type/No. 10,155/U.S.N.M.," and "Flebotomus cruciatus Coq." This is the only specimen bearing a red, numbered type label, and the only specimen bearing the identification in Coquillet's handwriting. This specimen is hereby selected as lectotype of *Phlebotomus cruciatus* Coq.

Slide B. This bears three printed labels glued to the left-hand side of the slide, as follows: "Alta V. Paz/Guatemala," "18.4 Cacao/Trece Aguas," and "Barber and Schwarz Coll." Written below these is "5051/A. Dampf prp 18/IV 36." The right hand side of the slide bears a written label as follows: "Phlebotomus cruciatus Coq./ ♀ / Drawn by Dampf." This is the slide from which the drawing in our 1948 paper was made.

Slide C. This bears a label on the left-hand side, written by R. C. Shannon according to Dr. Stone, but no printed labels. It reads as follows: "Phlebotomus cruciatus Coq./Paratype ♀ / Cacao, Trece Aguas / Apr. 26 Alta V. Paz/Guatemala." This is the only slide of the four labelled as paratype.

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[1]Cost of publication is paid by the Gorgas Memorial Laboratory.

Slide D. This bears three original printed labels glued onto left-hand side of slide, as follows: "Apr. 2 Cacao/Trece Aguas," "Alta V. Paz/Guatemala," and "Schwarz & Barber coll." On the right-hand side of slide is a label in Dampf's writing reading "Phlebotomus cruciatus Coq. ♀."

Although all significant structures cannot be seen on every specimen, the pigmentation of the pleura, the rugose or papillate lobes on the ninth tergite and the ducts or spermathecae or both are visible on all specimens, and we are certain that all specimens represent a single species.

From the above we believe it is clear that at least the four mounted specimens are *P. cruciatus* Coq., that they are the specimens which were before Coquillett when he described the species, and that Slide A is the type of the species.

Floch and Abonnenc contend that the name is a ***nomen nudum***, basing their opinion on the following points:

1. The original description is so inadequate that it amounts to no description.
2. The type material was from three different localities in Guatemala and taken at different times.
3. No true type exists, and there is no guarantee that the specimens examined by Fairchild & Hertig 1948 were the species named by Coquillett.
4. The material of "*cruciatus*" is in too bad a state of preservation for details to be made out.

We agree that the original description is inadequate, but so long as type material exists the name cannot be disregarded. As F. W. Edwards says (1932 p. 3) "Where a type exists a specific name must be regarded as valid from the date of its publication, even if the original description is hopelessly inadequate or even inaccurate. . . ."

All the specimens were, of course, from the same locality. Cacao was a farm in the neighborhood of Trece Aguas, Province of Alta Vera Paz, Guatemala. As shown above, a true type exists and it and the other specimens taken at the same locality are conspecific and in a reasonably good state of preservation.

Since 1948 we have seen the following additional material of *cruciatus* 1 ♂ 5 ♀ from two localities in Chiapas, Mexico, 3 ♂, 3 ♀ from three localities in Costa Rica and a long series of both sexes from several localities in Panama. All the females in the above material agree among themselves and agree as well with the types and with the Mexican and Guatemala material previously discussed in possessing the two characters which seem to most clearly separate the species from *gomezi* Nitz. To these two characters, the anterior dorsal papillate lobes on the ninth tergite and the shorter and thicker ducts of the spermathecae, must be added the possession of strongly pigmented pleura in addition to the dark mesonotum and scutellum. In *cruciatus* the postpronotum (Crampton 1925) and a strip of sclerotization lying below the lateral border of the mesonotum and above the mesothoracic spiracle, which appears to be a posterior prolongation of the postpronotum, are as heavily infuscated as the mesonotum. The sclerites before and above the base of the front coxa are also infuscated, and there is often a fainter

darkening of the other pleural sclerites. In *gomezi* the infuscation is confined entirely and sharply to the mesonotum and scutellum. This character is sharp and definite in all material we have seen, and enables the two species to be separated at a glance under low magnification.

The males which we associate with females of *cruciatus* resemble very closely the males of *gomezi*, but are distinguishable by the aforementioned infuscated pleural sclerites and by a relatively and actually larger sperm pump and heavier genital filaments. Counts of the number of hairs in the basal tuft of the coxite show considerable and overlapping variation in both species. In Panama the distribution of the two species shows interesting features. *Cruciatus* has been taken in but six localities in Panama, all but one on the Atlantic side of the continental divide. Four of these localities have yielded but one or two specimens; of the other two, Almirante, in Bocas del Toro Province has yielded the bulk of over 140 specimens while the Mojinga Swamp area near Ft. Sherman in the Canal Zone has yielded 11. *Gomezi* has been taken in nearly 70 localities on both sides of the continental divide. It appears to be absent entirely from Almirante and two of the other localitites that have yielded *cruciatus*, but is fairly abundant at the remaining three localities which have each yielded a single specimen of *cruciatus*. In no case in Panama do both species occur abundantly together.

In Costa Rica *cruciatus* has been taken in three localitites and *gomezi* in four, but only one place, Turrialba, has yielded both species. We have seen no Mexican or Guatemalan material of *gomezi* though *cruciatus* appears to be not uncommon and fairly widespread there. As reported previously, we have examined *gomezi* from Trinidad, Venezuela and Ecuador, and it has been reported by others from Para and S. Paulo, Brasil. It would seem likely that *cruciatus* may reach its southern limit in the Panama area, while *gomezi*, primarily a South American species, extends northward to somewhere between Costa Rica and Guatemala.

In 1948 we noted that, based on available descriptions, *P. diabolicus* Hall from Texas was separable with difficulty, if at all, from *gomezi* or *cruciatus*. Through the kindness of Dr. Alan Stone of the United States National Museum one of us (M.H.) had the opportunity to examine the mounted type material of this species and to borrow and make slide mounts of some unmounted material, including a male Paratype. This material consists of a male paratype, Uvalde, Texas, 3 Nov. 1934, A. W. Lindquist coll., Bishopp No. 20118, and 4 female specimens, Uvalde, Texas, 28 Sept. 1944, H. M. Brundrett coll., Bishopp No. 14244 (3) and Uvalde, Texas, 16 June 1943, on man, Bishopp No. 14241 (1). Two of the specimens lack abdomens, but all agree in other respects.

There seems to have been a clerical error in regard to the types of this species, leading to some subsequent contradictions, though it does not materially affect the validity of the species. In the original description the types are stated to consist of a male holotype, U.S.N.M. 51411, Uvalde, Texas, November 14, 1934, A. W. Lindquist coll., a female allotype, U.S.N.M. 51411, same data as holotype, both mounted on slides, and an unspecified number of Paratype specimens from Uvalde,

Texas mounted on card points. Earlier in Hall's paper he states that "The description is based upon specimens reared or collected at Uvalde, Tex., by A. W. Lindquist. . . ." Lindquist's paper (1936) on the early stages of this species says that engorged specimens were secured at both Uvalde and Del Rio, Texas. He mentions specimens taken November 16, 1933 and May 3, 1934. Addis (1945) in his redescription of the species used specimens collected at Uvalde, Texas by Mr. and Mrs. H. M. Brundrett, Oct. and Nov. 1944, which he says he compared with the female allotype collected by Lindquist at Uvalde, Nov. 14, 1934.

The mounted material of *diabolicus* examined in Dec. 1951 at the United States National Museum consisted of three slides, labelled as follows:

Slide A. This is a whole mounted ♂ under a circular cover glass on the right-hand end of the slide. Mounted in the balsam with the specimen is a label reading Bishopp No. 16451. In the middle of the slide is a red Type label reading "Type No. 51411 U.S.N.M." and on the left-hand end of the slide the label reads "Phlebotomus diabolicus Hall./♂ term,/Uvalde, Tex./Jun. 10-'33/A. W. Lindquist/Bish./16451."

Slide B. This is a whole mounted ♀, not well cleared, also mounted on the right side of the slide and with the same Bishopp number in the balsam with the specimen. The middle of the slide bears a red type label reading "Allo. Type No. 51411 U.S.N.M." The left-hand label bears the same data as for Slide A above, except for "♂ term."

Slide C. A whole ♀ mounted under a circular cover slip in the center of the slide. The label on one end, written at right angles to the long axis of the slide, is red and reads "Phlebotomus diabolicus Hall/Uvalde, Tex. IX-15-34/A. W. Lindquist colr./Bish, No. 20118/Paratype/Type No. U.S.N.M."

There are also three other slides, each bearing a single wing, and with the same collecting data as Slides A and B above. It is to be noted that the data on none of these specimens agrees with the data published by Hall or with the "allotype" which Addis claimed to have studied. Upon enquiry neither Dr. Bishopp's office or Mr. Hall himself were able to account for the discrepancy. The matter is not of great importance, since there is no evidence that more than one species was involved. Mr. Hall's drawing seems almost certainly to have been made from Slide A, the position of the parts agreeing fairly well, and there being no other known mounted specimens of the male at that time. His figure shows the deciduous hairs of the coxite far too heavy, and the basal tuft not in sufficient detail, but is otherwise recognizable. It is possible that Addis actually studied slide C above, but erred in transcribing the data. This specimen, however is a paratype. Or perhaps he studied the true allotype, Slide B above, but took the data from Hall's paper rather than the specimen itself.

In addition to the above mounted material from the type series, there are four slides of females, presumably *diabolicus*, in United States National Museum, but taken in 1936, 1940 and 1945. They were not closely studied, except to ascertain that the spermathecae were invisible in all. Neither the allotype nor paratype slides, B and C above, showed these structures.

Examination after mounting in Panama of the male paratype and the four topotype females loaned to us, enables us to complete in some respects the descriptions of Hall and Addis. The species turns out to be distinct from both *gomezi* and *cruciatus*, although the differences are relatively slight. We give below expanded descriptions and figures of *cruciatus*, *diabolicus* and *gomezi*, and keys for their separation.

KEY TO MALES

1. Mesonotum, scutellum and pleura markedly infuscated; ascoids of fourth antennal segment one-fourth or less length of segment 2
   Mesonotum and scutellum infuscated, pleura entirely pale; ascoids of fourth antennal segment about one-third length of segment ..... **gomezi**
2. Genital pump large, the plunger heavy and with widely flaring "pavillon"; basal tuft of 9 to 25 rather heavy setae ..... **cruciatus**
   Genital pump more slender, the "pavillon" of the plunger cup-shaped; Basal tuft of 8 more slender and slightly shorter setae ..... **diabolicus**

KEY TO FEMALES

1. Mesonotum, scutellum and pleura markedly infuscated; ducts of spermathecae rather heavy, about four times as long as the spermathecae; ninth tergite with heavily sclerotized dorsolateral lobes bearing small to prominent conical papillae 2
   Mesonotum and scutellum infuscated, pleura entirely pale; ducts of spermathecae over five times as long as spermathecae, quite slender; ninth tergite without sclerotized papillate lobes ..... **gomezi**
2. Cibarium with 8 to 10 heavy blunt vertical teeth below the four horizontal teeth; chitinous arch diffuse in the middle; spermathecae with numerous fine annulations (not countable in available material but probably exceeding 30) ..... **diabolicus**
   Cibarium with more numerous small vertical teeth; chitinous arch usually clear cut and of nearly equal width throughout; spermathecae with about 15 annulations ..... **cruciatus**

Phlebotomus cruciatus Coquillett

Figs. 1–4, 8, 13, 16, 19, 21, 25

1907, Ent. News, 18: 102 (♀: Cacao, Trece Aguas, Alta Vera Paz. Guatemala). Fairchild and Hertig, 1948, Ann. Ent. Soc. Amer., 41 (2): 247–252 and figs. (♀: Chiapas, Tabasco and San Luis Potosi, Mexico; Esquintla, Guatemala. Full references). Floch and Abonnenc, 1950, Inst. Pasteur de la Guyane, pub. 212, pp. 1–3.

Male.—Wing length 2.00 mm. (Chiapas specimen) and 1.59 to 1.84 mm. (Costa Rica and Panama specimens). The four males from Esquintla, Guatemala measure 1.48 to 1.63 mm. Venation as figured (fig. 25). A moderatley large sandfly with mesonotum, scutellum, upper anterior border of pleura, abdominal dorsum and head quite heavily infuscated, as in *diabolicus* (fig. 12). Abdominal hairs erect, not scale like. Postspiracular setae from 15 to 30, lower mesanepisternal setae 3 to 9. Head height slightly greater than length of proboscis and a little more than two-thirds head width. Basal antennal segments and palpi as figured (fig. 16), end of third antennal segment reaching to about middle of third palpal segment when both attached to head. Newstead's scales sparse, slender and clubbed, difficult to see, but apparently confined to the middle third of the third palpal segment. Ascoids simple, exceedingly short, as figured (fig. 19), paired on all but the last three segments, which are rather abruptly shorter than the preceding segment. Cibarium with a strong arch which is usually clear cut

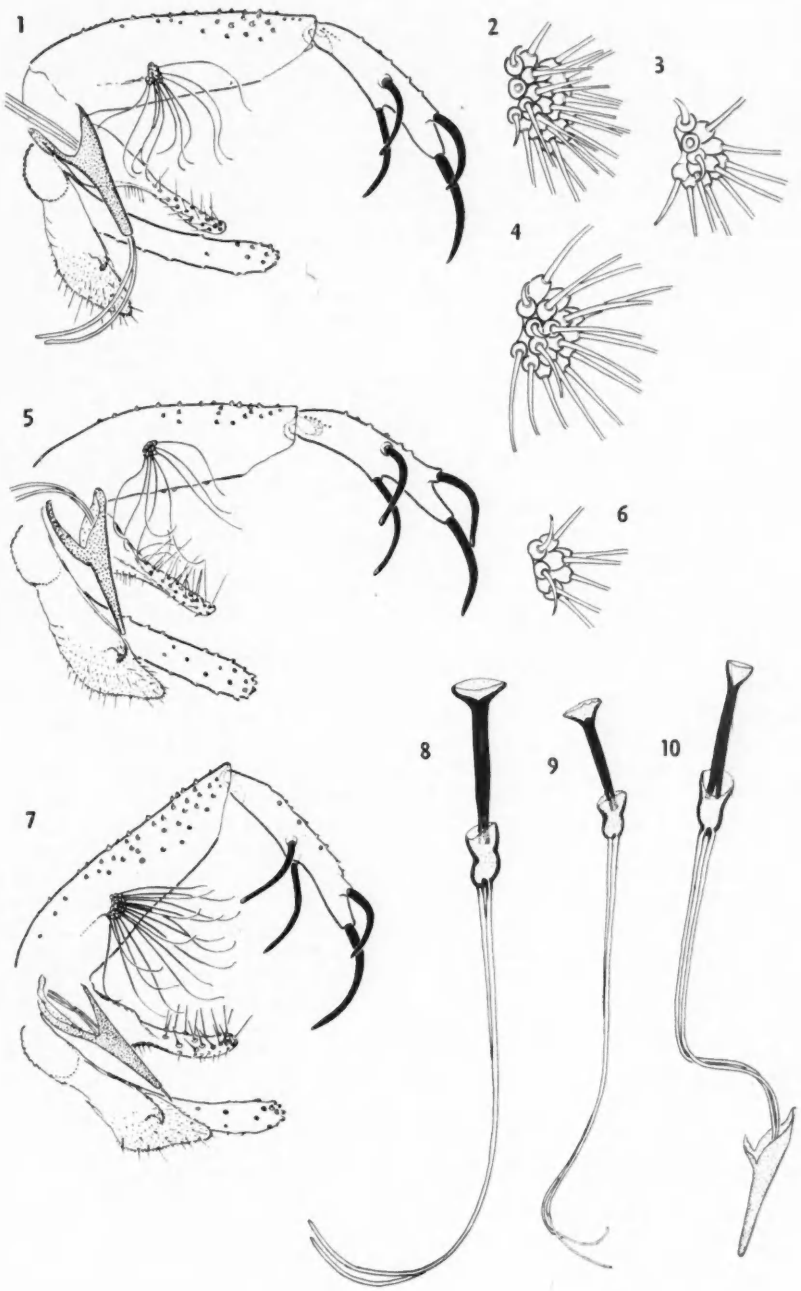
throughout, no regular cibarial teeth, but numerous minute denticles and a well-marked pigment patch. Pharynx slender, wrinkled at apex and with minute denticles. Genitalia as figured (fig. 1), the setae in the basal tuft varying from 13 to 20 except on one specimen from Guatemala which bears 25 and one from Costa Rica which has but 9 (figs. 2–4). Genital pump and filaments as figured (fig. 8), the filaments 2.7 times as long as pump. Anterior sternites as figured (fig. 21).

Female.—Wing length 2.01 to 2.16 mm. (Chiapas specimens), 1.77 to 2.05 mm. (Costa Rica and Panama specimens). The material from Mexico previously reported on by us (Chiapas, Tabasco and S. Luis Potosi) shows the same range of measurements as the Panama material. Coloration as in male. Postspiracular setae ligulate or scale-like, 21 to 33 in Chiapas specimens, 19 to 28 in Costa Rica and Panama specimens. Lower mesanepisternal setae narrowly ligulate, 6 to 12 in Chiapas specimens, 4 to 7 in Costa Rica and Panama specimens. Proboscis slightly greater than head height, the latter about two-thirds of head width. Basal antennal segments and palpi as in male, the end of third antennal segment reaching to about the middle of third palpal segment. Newstead's scales as in male, though at least in some specimens they are present also on apical third of second palpal segment. Ascoids as figured (fig. 10), with short posterior prolongations, considerably longer than in male, but not attaining ends of their respective segments; paired on all segments, or more usually, paired on all segments but the terminal one. Cibarium with a strong arch, a narrow pigment patch, four horizontal teeth and scattered small vertical teeth, as figured (fig. 13). Pharynx as in male, but stouter. Spermathecae as figured by us in 1948 (Pl. I, figs. 5, 6), the ducts opening separately into the vagina. Sides of eighth tergite without setae. Dorsum of ninth with simple setae, its anterior margin with a pair of anterior dorsolateral lobes, which are heavily sclerotized and thickly beset with conical papillae, each of which bears a minute seta. Wing clothed with hairs; a few ligulate striate scales at base.

The above description is based on an examination of the following slide mounted material, in addition to the types and the material previously listed by us: 1 ♂ 2 ♀, Sta. Maria, Cintalapa, Chiapas, Mexico, 11–12 April 1951, in tree buttresses, Fairchild and Hartmann coll.; 3 ♀, Palenque, Chiapas, Mexico 31 March 1951, one taken biting in the forest during the day, the other two at light in a Shannon trap; 1 ♂, Lagartos on highway on border between Puntarenas and Guanacaste, Costa Rica, 13 Dec. 1951, in buttress, R. Rosabal coll.; 1 ♂, 1 ♀, Turrialba, Costa Rica, 11 Feb. 1952 and 12 April 1951; 1 ♂, 1 ♀, Cruces Trail, C.Z. Forest Reserve, 5 July and 10 Aug. 1951, in buttress

EXPLANATION OF PLATE I

FIG. 1. *P. cruciatus*, male genitalia, Panama, × 152. FIGS. 2–4. *P. cruciatus*, basal tufts on specimens from Guatemala, fig. 2; Panama, fig. 3, and Mexico, fig. 4, all × 520. FIG. 5. *P. diabolicus*, male genitalia, paratype, × 152. FIG. 6. *P. diabolicus*, basal tuft on coxite, paratype, × 520. FIG. 7. *P. gomezi*, male genitalia, Panama, × 152. FIGS. 8–10. Genital pumps and filaments of *P. cruciatus*, Panama, fig. 8; *P. gomezi*, Venezuela, fig. 9, and *P. diabolicus*, paratype, fig. 10, all × 152.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and in Shannon trap at light; 1 ♀, Rio del Medio, Rio Gatun, Canal Zone, 13 Oct. 1949, in hollow tree; 15 ♂, 27 ♀, from near Almirante, Bocas del Toro province, Panama, various dates from April through August. We have also identified considerable additional material, over 100 specimens, from the Almirante area, but these have not been mounted.

Phlebotomus diabolicus Hall

Figs. 5, 6, 10, 12, 14, 15, 17, 22, 23, 26

1936, Proc. Ent. Soc. Washington, 38 (2): 27–29, fig. 2 (♂, ♀; Uvalde, Texas). Lindquist, 1936, Proc. Ent. Soc. Washington, 38 (2): 29–32, figs. 1–2 (early stages; Del Rio, Sonora and Uvalde, Texas). Floch and Abonnenc, 1943, Inst. Pasteur Guyane, pub. 62, p. 6 (♂; in key only). Addis, 1943, J. Parasit., 31 (2): 125–127, Pl. 2 (♂, ♀; Uvalde, Texas); 1945, Trans. Amer. Microscop. Soc. 64 (4): 331, figs. 4, 8, 9 (♂, ♀; in keys). Packchanian, 1946, Texas Rep. Biol. Med., 4 (1): 38. Barretto, 1947, Arq. Zool. São Paulo, 5 (4): 197. Fairchild and Hertig, 1948, Ann. Ent. Soc. Amer., 41 (2): 250. Barretto, 1951, Arq. Hig. Saude Pub. 15 (46): 216. Vargas and Diaz Najera, 1952, Rev. Invest. Clin., Mexico, 4 (1): 50 (♂, Guerrero, Mexico).

Male.—Wing length 1.89 mm., venation as figured (Fig. 26). Mesonotum, scutellum, pleura and coxae all strongly infuscated (Fig. 12), as is the head, abdomen and genitalia. Abdominal setae apparently erect, not scale like. Post spiracular setae 17, lower mesanepisternal setae 3, rather broad and scale-like. Proboscis is a little less than head height, the latter a little over two-thirds head width. Palpi and basal antennal segments as figured (fig. 15). Newstead's scales on the proximal half of third and apical third of second palpal segments, slender, clubbed and fairly numerous. Ascoids very short and slender (fig. 17), paired on all but last three antennal segments, which are rather abruptly shorter than the preceding segments. Cibarium with a few minute denticles; chitinous arch well marked at sides but hardly perceptible centrally; pigment patch slender, T-shaped. Pharynx with minutely denticulate wrinkles or ridges at its posterior end. Genitalia as figured (figs. 5, 6), filaments a little more than twice as long as pump, the latter rather slender with cup-shaped plunger, as figured (fig. 10). Anterior sternites as figured (fig. 22).

Female.—Wing length 1.99 to 2.17 mm. Venation as in male. Color and vestiture as in male. Postspiracular setae 12 to 16, lower mesanepisternal setae 4 to 8. Proboscis somewhat longer than head height, the latter about two-thirds of head width. Newstead's scales as in male, though present on nearly the full length of third palpal segment. Ascoids as figured (fig. 17), with very short posterior pro-

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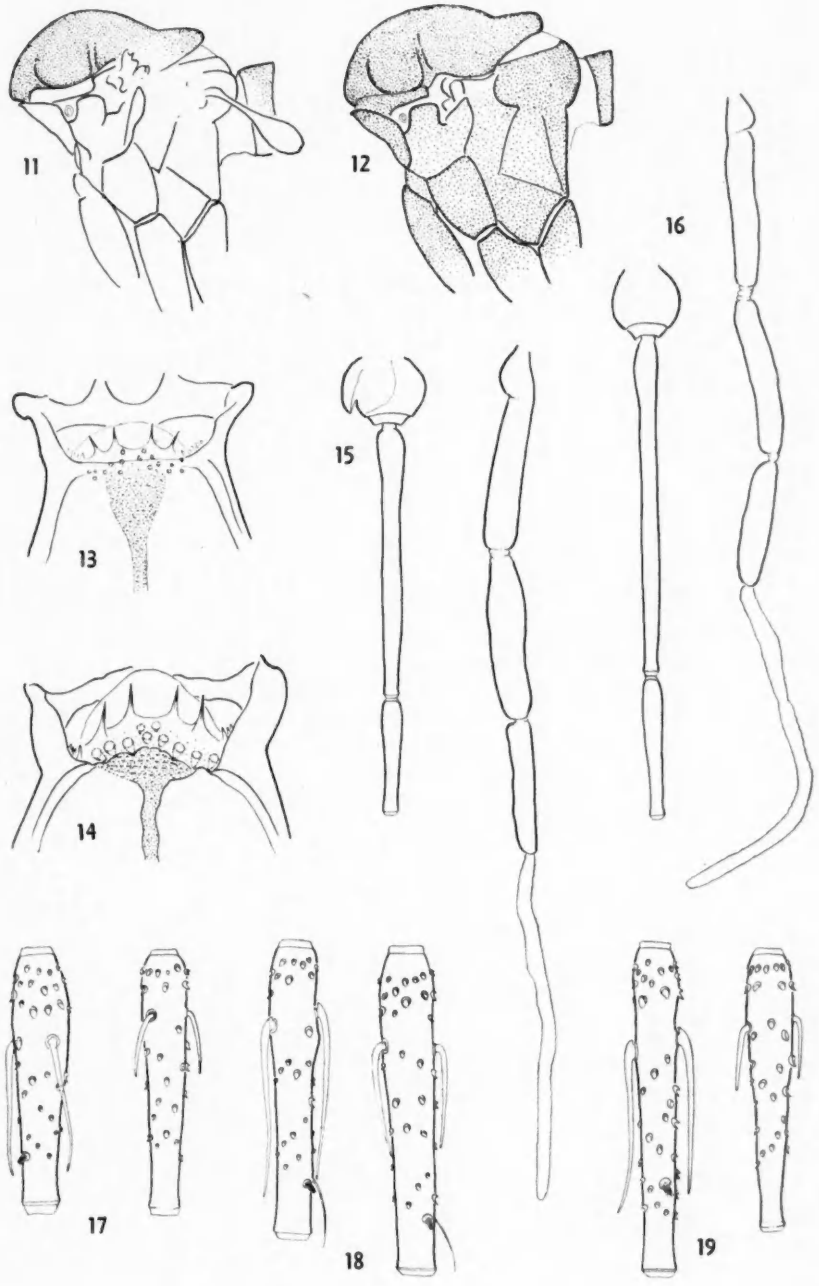
EXPLANATION OF PLATE II

FIG. 11. *P. gomezi* male, Panama, thorax, × 52. FIG. 12. *P. diabolicus* male, paratype, thorax, × 52. FIG. 13. *P. cruciatus*, female cibarium, Mexico, × 795. FIG. 14. *P. diabolicus*, female cibarium, topotype, × 795. FIG. 15. *P. diabolicus* male, basal antennal segments and palpi, paratype, × 152. FIG. 16. *P. cruciatus* male, basal antennal segments and palpi, Panama, × 152. FIGS. 17–19. Fourth antennal segments, female left, male right of *P. diabolicus*, Texas, fig. 17; *P. gomezi*, Panama, fig. 18, and *P. cruciatus*, male, Panama, female, Mexico, fig. 19, all × 350.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longation, longer than in male, paired on all but the last antennal segment. Cibarium as figured (fig. 14). Pharynx as in male. Ninth tergite with dorsolateral lobes as in *cruciatus*, but these are less heavily sclerotized and the papillae are smaller and less prominent. Setae of dorsum of ninth tergite simple; no setae on lateral aspect of eighth tergite. Spermathecae as figured (fig. 23).

Description drawn from the male paratype and four females from Uvalde, Texas previously mentioned.

Phlebotomus gomezi Nitzulescu

Figs. 7, 9, 11, 18, 20, 24

1931, Ann. Parasit. Hum. Comp. 9: 247–255, figs. 1–6, Pl. 4 (♀; San Cristobal, Venezuela). Fairchild and Hertig, 1948, Ann. Ent. Soc. Amer., 41 (2): 252–255, Pl. 1, figs. 1–3, Pl. 2, fig. 7 (♂, ♀; Panama, Costa Rica, Trinidad; full references). Floch and Abonnenc, 1950, Inst. Pasteur Guyane, pub. 212, pp. 3–5. Barretto, 1951, Arq. Hig. Saude Pub., São Paulo, 15 (46): 217.

Phlebotomus suis Rozeboom, 1940, Amer. J. Hygiene 32 (1), C: 8–11, figs. 1–5 (♂, ♀; Las Guacas, Panama).

Phlebotomus japignyi Floch and Abonnenc, 1944, Inst. Pasteur Guyane, pub. 83, pp. 2–5, figs. 2–3 (♂, ♀; near Cayenne, Fr. Guiana).

Phlebotomus trinidadensis Callan, 1947, Rev. Ent., 18 (1–2): 215–218 (Trinidad).

In 1948 we stated our belief that *P. japignyi* F. & A. was not separable from *P. gomezi* Nitz. Since then Floch and Abonnenc (1950) have reopened the question and pointed out certain characters by which they believe *japignyi* can be consistently separated from *gomezi*. This has made it necessary for us to go over our material again and check more carefully the points raised in their paper. These differences may be summarized as follows.

1. In the male, *japignyi* shows but 10 setae in the basal tuft of the coxite, constant in six specimens, while *gomezi* shows 14 to 18 in Venezuelan specimens.

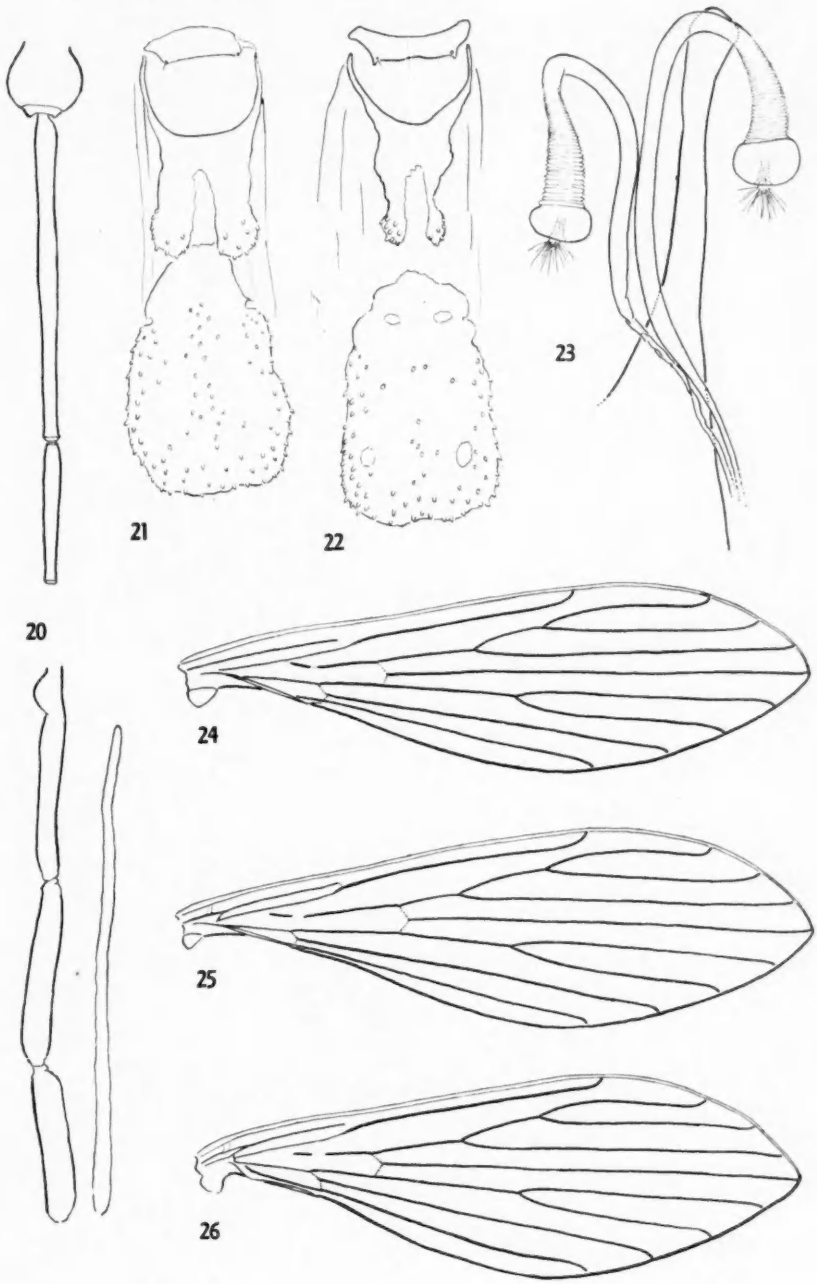
2. The length of the genital filaments relative to the genital pump in *japignyi* is 2.1, *i.e.*, the filaments are 2.1 times as long as the pump. In *gomezi* from Venezuela the proportions vary from 3.2 to 3.4.

3. In the female the spermathecal ducts in *japignyi* measure 0.290 mm. while in *gomezi* they measure from 0.180 to 0.220.

We have counted the hairs in the basal tuft of 17 specimens, 8 from Panama, 6 from Venezuela, 2 from Costa Rica and 1 from Trinidad. The numbers range from 13 ± 2 to 19 ± 2. We found it quite difficult to count these setae on most specimens; in only four cases were the genitalia so oriented that a clear count could be made. In these cases the counts were 14, 14, 15 and 18 setae, so that disregarding several specimens on which uncertain counts of 13 setae were made, Floch and Abonnenc are correct in their statement regarding *gomezi*.

EXPLANATION OF PLATE III

FIG. 20. *P. gomezi* male, basal antennal segments and palpi, Venezuela, × 152. FIGS. 21–22. First three abdominal sternites of males of *P. cruciatus*, Panama, fig. 21 and *P. diabolicus*, paratype, fig. 22, × 152. FIG. 23. *P. diabolicus*, spermathecae, drawn from specimen mounted in copal-balsam, topotype, × 585. FIGS. 24–26. Wings of males of *P. gomezi*, Panama, fig. 24; *P. cruciatus*, Mexico, fig. 25, and *P. diabolicus*, paratype, fig. 26, all × 43.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The ratios genital pump/genital filaments of one specimen from Trinidad, seven from Venezuela and six from Panama range from 3.0 to 3.8, the Trinidad specimen being 3.1, Venezuelan specimens 3.0–3.8, and Panama specimens 3.0–3.5. This again agrees fairly well with Barretto's (1946) figures for eight Venezuelan males quoted by Floch and Abonnenc, 3.2 to 3.4. It is to be noted, however, that though Floch and Abonnenc give 2.1 as the ratio for *japignyi*, their figure (1944) when measured gives a ratio of 2.65.

Measurements of the spermathecal ducts of 7 Panama specimens of *gomezi* give lengths ranging from 0.1715 mm. to 0.2640 mm,; single specimens from Venezuela and Trinidad a length of 0.2574 mm. This is a greater range and greater maximum length than given by Floch and Abonnenc, though still showing somewhat shorter ducts than indicated for *japignyi*, 0.290 mm. Our measurements were taken from specimens mounted in balsam. Two fresh Panama specimens were measured in water after treatment with KOH and gave measurements of 0.2244 mm. and 0.2409 mm.

These differences seem to us too slight a basis on which to maintain the species, especially since no specimens of *gomezi* appear to have been taken in French Guiana, though the species occurs in Venezuela and Trinidad, some 700 miles to the west, and has been reported from Belem at the mouth of the Amazon about 500 miles to the southeast. It is our opinion that *japignyi* is at most a race of *gomezi*, and it might be well to retain the name in this sense until series of both sexes from a wider range of localities can be studied.

Male.—Wing length 1.65 mm. to 2.00 mm., measurements based on seven specimens from Panama, four from Venezuela and two from Costa Rica. Mesonotum and scutellum heavily infuscated but pleura and coxae entirely without pigment (Fig. 11). Postspiracular setae 4 to 13, lower mesanepisternal setae 6 to 13, the counts based on the same specimens yielding the wing measurements. Head slightly infuscated, the proboscis just equalling head height, the head a little more than two-thirds as high as wide. Basal antennal segments and palpi as figured (fig. 20), end of third antennal segment reaching to middle of third palpal segment when attached to head. Newstead's scales slender, clubbed, scattered over the distal third of second palpal segment and most of third segment. Ascoids simple, short, as figured (fig. 18), paired on all but the last three antennal segments, which are rather abruptly shorter than those preceding. Cibarium with a distinct though poorly sclerotized chitinous arch; the cibarial armature represented by several rows of minute denticles; the pigment patch weak and slender. Pharynx with numerous transverse minutely denticulate ridges. Genitalia as figured (fig. 7), the basal tuft of the coxite bearing from about 13 to about 19 setae. Genital filaments from 3.0 to 3.8 times as long as pump, as figured (fig. 9). Anterior sternites as figured previously by us (1950).

Female.—Wing length 1.70 mm. to 2.20 mm., based on nine specimens from Panama, Venezuela and Costa Rica. Coloration as in male. Post spiracular setae 6 to 16, lower mesanepisternal setae 7 to 12, based on same specimens. Proboscis exceeding head height by nearly one-third its length; head height about two-thirds head width. Basal

antennal segments and palpi as in male, end of third antennal segment not reaching end of second palpal segment when both undetached. Newstead's scales as in male. Ascoids as figured (fig. 18), with a short posterior prolongation and much longer than in male, paired on all but the last antennal segment, which is longer than the penultimate segment. The slender hollow spine shown near the apex of the segment in both sexes of *gomezi* is usually visible in this species and there are sometimes two on opposite sides of the segment. They are occasionally visible on *cruciatus* but have not been seen definitely in the few specimens of *diabolicus* examined. They seem to be of the same structure as the numerous non-deciduous setae borne on the terminal segments of the antennae in most species of *Phlebotomus*. Cibarium as figured by us (1948), sometimes with the chitinous arch more pointed. Pharynx as in male, but broader. Spermathecae as figured by us in 1948, often showing fine pseudoannulations and joining in a short common duct before the vagina. Sides of eighth tergite with from one to five setae, usually two or three. Ninth tergite without dorsolateral papillate sclerotized lobes, the setae mostly simple, but with a few narrowly ligulate scale-like setae. Wing venation as in male, the wing clothed with simple setae except for a few square-ended striate scales at base.

The above description is drawn from slide mounted material from numerous localities in Panama, and from Caripito, San Cristobal and Cabimas, Venezuela; St. Augustine, Trinidad; Rio Seco, Paquera, Sta. Cruz and Puerto Jimenez, Costa Rica. We have also examined cleared but unmounted material from a number of other localities in Costa Rica and from Quevedo, Ecuador, as well as several hundred specimens from additional localities in Panama.

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AN ANTIBACTERIAL AGENT FROM TRIBOLIUM CASTANEUM (HERBST)[1]

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INTRODUCTION

In general, animals of one species are not susceptible to all of the diseases affecting different species. Whether this is due to tissue protein differences, antibody differences, or the presence of inherent antibacterial or antibiotic substances is subject to speculation. Certainly the lower animals, such as insects, are not susceptible to many of the bacterial diseases affecting the mammals. There have been but few attempts to screen the many species of arthropods to find antibacterial substances. The classic example is the endeavor of Livingston and Prince (1932) to obtain an active principle from maggots. This work was predicated on an observation by Baer (1931) during World War I.

Nicholls (1912) found that larvae of the *Sarcophagula* raised in material infected with *Staphyococus aureus* were free from these bacteria in the pupal stage after the pupae were removed from infected surroundings. Glaser (1918) observed that the blood of insects is somewhat antagonistic toward bacteria, and found that actively immunized blood of the grasshopper shows a high degree of antagonism towards the bacteria used in producing the immunity. More recently, Frings, Goldberg, and Arentzen (1948) described the in vitro antibacterial action of the blood of the large milkweed bug, *Oncopeltus fasciatus* Dallas, against *S. aureus* and one strain of *Bacillus subtilis*. In the same year Pavan (1948) reported a new antibiotic from the Argentine ant, *Iridomyrmex pruinosus humilis* Mayr, which he named Iridomyrmecin. It is claimed by Pavan that this material has antibacterial properties in vitro against gram-negative, gram-positive, and acid resistant bacteria, as well as having insecticidal properties. An excellent review of the literature on the role of insects and arachnids in producing antibacterial substances is given by Perry (1951).

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[1]This work is not to be construed as necessarily reflecting the views of the Department of the Navy.

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The question naturally arises, are there extractable antibacterial or antibiotic agents in other common insects? It is known that certain insects produce glandular secretions when aroused, possibly as a defense mechanism. The odoriferous secretions of *Tribolium confusum* Duv. have been studied by Roth (1941). In fact, Alexander and Barton (1943) claim to have identified the secretion from *T. castaneum as* ethylquinone. However, no study of antibacterial properties was made, although quinones in general have antibacterial properties. (Florey, 1949). It is the purpose of this paper to present the result of screening, for antibacterial agents as many species as could be field-caught in the area of Camp Lejeune over the past two years; and to report a special study of extracts of *T. castaneum* as an antibacterial agent.

SCREENING PROCEDURE

Arthropods were collected in the field, ground with mortar and pestle, extracted either with alcohol, ether, acetone, or physiological saline, and the resulting solution refrigerated and tested for antibacterial activity against *Escherichia coli* and *S. aureus*. This was accomplished by saturating a filter paper disc (12.8 mm.) with 0.1 cc of the supernat-

TABLE I

ARTHROPODS USED IN PREPARING AQUEOUS EXTRACTS FOR DETERMINATION OF BACTERICIDAL PROPERTIES

Hexapoda

ORTHOPTERA
- Gryllidae
  - *Gryllus assimilis* Fab. (3)
  - *Nemobius fasciatus* Deg. (5)
  - *Gryllotalpa hexadactyla* Pert. (5)
- Blattidae
  - *Periplaneta americana* (Linn.) (5)
  - *Blatella germanica* (Linn.) (3) (5)
  - *Parcoblatta* sp. (5)
- Mantidae
  - *Stagmomantis carolina* (Johan.) (5)
- Acrididae
  - *Schistocera americana* (Drury) (3) (5)
  - *Melanoplus* sp. (3)
  - *Orphulella* sp. (3)

ODONATA
- Libellulidae
  - *Pachydiplax longipennis* Burm.(3)

ISOPTERA
- Rhinotermitidae
  - *Reticulitermes flavipes* Koll. (6)

HOMOPTERA
- Coccidae
  - *Pseudophilippia quaintancei* Ckll. (5)
  - *Toumeyella* sp. (3) (5)
- Aphididae
  - *Brevicoryne brassicae* Linn. (3) (5)
  - *Myzus persicae* (Sulzer) (3) (5)
  - *Macrosiphum pisi* Kalt. (5)
  - *Macrosiphum sanborni* (Gill.) (5)
- Membracidae
  - *Platycotis vittata* (F.) (3)
- Cicadellidae
  - *Stirellus bicolor* (VanD.) (5)
  - *Graphocephala versuta* Say (5)
  - *Chlorotettix viridius* VanD. (5)
  - *Draeculecephala balli* VanD. (5)
  - *Oncometopia undata* Fab. (5)

HEMIPTERA
- Coreidae
  - *Leptoglossus phyllopus* Linn. (3) (5)
- Miridae
  - *Lygus apicalis* Fieb. (5)
- Pentatomidae
  - *Murgantia histrionica* Hahn (5)
  - *Euschistus servus* Say (5)

COLEOPTERA
- Cerambycidae
  - *Rhagium lineatum* Oliv. (2)
- Dermestidae
  - *Dermestes maculatus* Deg. (5)
  - *Dermestes* sp. (2)
- Carabidae
  - *Harpalus faunus* Say (5)
  - *Brachinus* sp. (5)
- Anobiidae
  - *Lasioderma serricorne* Fab. (5)
- Nitidulidae
  - *Pallodes silaceus* Er. (5)
  - *Carpophilus melanopterus* Er. (5)
- Coccinellidae
  - *Cycloneda munda* (Say) (5)
  - *Epilachna corrupta* Muls. (5)
  - *Megilla maculata* Deg. (5)
  - *Coccinella novemnotata* Hbst. (5)

TABEL I—(*Contined*)

Passalidae
Passalus cornutus Fab. (5)
Cicindelidae
Cicindela sexguttata Fab. (5)
Tenebrionidae
Tribolium confusum Duv. (5)
Tribolium castaneum Hbst. (2) (4) (5)
Uloma punctulata Lec. (5)
Scarabaeidae
Phanaeus carnifex Linn. (5)
Onthophagus hecate Panz. (5)
Phyllophaga hirticula Kn. (5)
Cotinis nitida Linn. (5)
Rhynchophoridae
Sitophilus oryzae Linn. (5)
Cantharidae
Chauliognathus pennsylvanicus Deg. (5)
Lampyridae
Photinus sp. (5)
Alleculidae
Hymenorus sp. (5)
Elateridae
Ischiodontus soleatus Cand. (2)
Staphylinidae
Gyrophaena sp. (2)
Cucujidae
Oryzaephilus surinamensis (Linn.) (5)

NEUROPTERA
Myrmeleonidae
Myrmeleon immaculata Deg. (2)

LEPIDOPTERA
Danaidae
Danaus plexippus Linn. (5)
Sphingidae
Protoparce sexta Hoh. (2)
Notodontidae
Datana major G. and H. (2)
Arctiidae
Hyphantria cunea Drury (2)
Citheroniidae
Anisota senatoria S. and A. (2)
Noctudiae
Heliothis obsoleta Fab. (2)
Geometridae
Lygris diversilineata Hb. (5)
Notodontidae
Datana sp. (5)
Yponomeutidae
Atteva aurea Fitch (5)

HYMENOPTERA
Formicidae
Dorymyrmex sp. (6)
Pogonomyrmex badius (Latr.) (6)
Dorymyrmex pyramicus (Rog.) (6)
Formica fusca var. *subsericea* Say (6)
Camponotus abdominalis floridanus (Buck) (6)
Argidae
Arge sp. (2)
Andrenidae
Andrena sp. (5)
Scoliidae
Scolia bicincta Fab. (5)
Scolia dubia Say (5)
Campsomeris plumipes fossulana Fab. (5)
Campsomeris plumipes plumipes Drury (5)
Tiphiidae
Tiphia inaequalis Mall. (5)
Xylocopidae
Xylocopa micans Lep. (5)
Xylocopa virginica (Linn.) (5)
Sphecidae
Chlorion (*Isodontia*) *auripes* Fern. (5)
Chalybion californicum (Sauss.)
Vespidae
Polistes exclamans exclamans Vier. (5)
Polistes bellicosus Cr. (5)
Psammocharidae
Lophopompilus aethiops Cr. (5)
Mutillidae
Dasymutilla nigripes Fab. (5)
Bombidae
Bombus fraternus Sm. (5)
Psithyrus laboriosus Fab. (5)
Apidae
Apis mellifera Linn. (5)

DIPTERA
Sarcophagidae
Sarcophaga sp. (2)
Fungivoridae
Lycoria (*Sciara*) sp. (2)
Syrphidae
Eristalis saxorum Wied. (5)
Meromacrus acutus Fab. (5)
Stratiomyiidae
Hermetia illucens (Linn.) (2)
Tachinidae
Archytas hystrix Fab. (5)
Muscidae
Musca domestica Linn. (5)
Culicidae
Aedes sollicitans Wlk. (1) (5)
Culex salinarius Coq. (2) (5)
Culex restuans Theo. (2) (5)

Arachnida

ARANEIDA
Argiopidae
Miranda aurantia Lucas (5)
Theridiidae
Latrodectus mactans (Fab.) (5)

ACARINA
Ixodidae
Amblyomma americanum Linn. (3) (5)

Legend: (1) eggs, (2) larvae, (3) nymphs, (4)pupae, (5) adults, (6) workers (termite).

ant solution. The disc was placed on a plate of nutrient agar previously seeded with the test organism. After 24 hours' incubation the diameter of the zone of inhibition was measured and recorded.

Table I gives the genera and species of the insects tested. None of the insects presented in this table showed any antibacterial activity (against *E. coli* or *S. aureus*) except *T. castaneum* and *T. confusum*.

Tribolium castaneum

After the initial finding that this species gave strong antibacterial activity against *E. coli* and *S. aureus*, it was decided to rear this species in the insectary for further detailed studies. The beetles that gave the initial positive tests were found in a sack of dog food used in the laboratory for feeding mosquito larvae. These beetles were subsequently transferred to glass jars (12 inches in diameter, 12 inches in height) containing whole wheat flour to a depth of 3 inches. The jars were topped by either glass or plywood and kept in the insectary under constant conditions (88° F. ± 2, and 68% ± 2 relative humidity). When beetles were needed for bacterial or chemical tests they were trapped from the flour by placing squares of corrugated cardboard slightly above the surface of the flour on wooden blocks (DeCoursey, 1931). Using 200 beetles per ml. of extracting fluid, thirty-five separate tests involving approximately 61,600 beetles were made. An average zone of inhibition of 26.8 mm. against *E. coli* and of 32.6 mm. against *S. aureus* resulted.

Aqueous extracts of the beetles were found to produce zones of inhibition on agar plates seeded with the following organisms:

Staphylococcus aureus (209)
Staphylococcus albus
Escherichia coli (8676)
Escherichia coli B
Escherichia coli
Escherichia coli B/r
Bacillus subtilis
Bacillus subtilis var. *niger*
Mycobacterium smegmatis
Shigella paradysenteriae
Salmonella schotmülleri
Bacillus cereus
Serratia marcescens
Corynebacterium diphtheriae
Corynebacterium pseudo-diphtheriticum
Corynebacterium enzymicum
Corynebacterium xerose
Shigella flexneri[5]
Salmonella enteritidis
Bacillus anthracis[5]
Malleomyces mallei[5]
Pasteurella pestis[5]
Brucella suis[5]
Diplococcus pneumoniae—Type I
Bacterium tularense[5]

Aqueous extracts were not effective against the following fungi:

Trichophyton mentagrophytes
Trichophyton rubrum
Microsporum canis
Microsporum gypseum
Microsporum audouini
Epidermophyton floccosum

The following miscellaneous information has been obtained with regard to the beetle (*T. castaneum*) and its extract:

Active extracts were obtained from either male or female beetles.

By dissection and subsequent extraction it was found that the antibacterial activity was localized principally in the abdomen.

Larvae, pupae and fecal pellets were not antibacterial.

Beetles starved to death (one month without food or water) retained their antibacterial potency.

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[5]Tests made through the courtesy of the Navy Unit, Camp Detrick, Md.

Beetles reared on whole wheat flour or corn, and beetles obtained from other foods outside the laboratory yielded positive antibacterial extracts.

Beetles placed on wet filter paper imparted the active principle to the paper, which indicated that the antibacterial agent might possibly be a glandular secretion.

Rabbits fed 50 mg. of the dry extract twice daily for three days showed no clinical evidence of toxicity.

The active antibacterial agent from *T. castaneum* was extracted by the following solvents: water, physiological saline, ether, acetone, alcohol, dioxane, peanut oil, ethyl acetate, benzene, and carbon tetrachloride. Aqueous extracts dried to a powder by vacuum retained their antibacterial activity to a reduced extent; whereas, aqueous extracts dried to a powder by air jet were negative, indicating high volatility of the active agent. Aqueous extracts passed eight times through Permutit ion exchange resin remained active suggesting that the active principle was probably of an organic nature. Dialysis of aqueous extracts to remove protein did not destroy the antibacterial activity. Chemical deproteinization also did not destroy activity. Aqueous extracts retained the active principle for about one month when refrigerated in stoppered bottles at 40° F., but activity was markedly diminished in three days at room temperature (78° F.). Aqueous extracts retained their antibacterial activity after 30 minutes in a water bath at 212° F.

Carbon tetrachloride extract produced a large zone of inhibition against *E. coli* and *S. aureus* (40 and 60 mm.). Since this extract was relatively free of proteins it was extensively used in subsequent testing. This extract in carbon tetrachloride was stable under refrigeration for at least three months. Chemically the same reactions were given by the carbon tetrachloride extract as those given by a dialyzed aqueous extract of ground beetles. However, the carbon tetrachloride extract was yellow while the aqueous extract was claret color. The yellow carbon tetrachloride extract could be extracted with acid (pH5) water and by manipulation of acidity this could be made to turn claret color and then precipitate. The original aqueous extract had a pH of 5.6 and could be made to precipitate by manipulation of acidity. The carbon tetrachloride extract produced a claret color on most plates which was indistinguishable from the color left by the aqueous extract. The exceptions appeared to be colorless, but against an agar background weak colors would not show in any case.

From the work of Alexander and Barton (1943) it is to be suspected that a quinone is present in some quantity in the defense glands of *T. castaneum*. Inasmuch as aqueous and carbon tetrachloride extracts may be reduced (Zn/HCL) to colorless solutions; may be destroyed by oxidation, rapidly under basic conditions; are dialyzable through regenerated cellulose film; and are antibacterial in vitro; all facts well fitted to quinone chemistry, it seemed best to have an in vivo test made before continuing with attempts to identify the micro-quantities of material involved.

Since in vitro, the extracts of *T. castaneum* had been found to inhibit all types of bacteria tested, it was decided to compare the extracts

against standard penicillin in their action on *D. pneumoniae* (Type I) in mice. The dosage of *D. pneumoniae* injected into the mice intraperitoneally was LD_{50}, (20 deaths out of 40 mice). Forty mice received the test organism followed by 100 units of penicillin. All survived. Forty mice received the test organism followed by the carbon tetrachloride extract transferred to peanut oil. Seventeen mice survived. Thirty mice received the *pneumoniae* followed by the aqueous beetle extract. Twelve survived. These results indicate that the extracts of *T. castaneum* do not have any protective properties in mice infected with *D. pneumoniae.* This is also the expected result for a quinone solution.

Two control series of ten noninfected mice each were run to determine the toxicity of the aqueous and the oil extracts of *Tribolium castaneum.* In both series nine of the ten mice survived.

SUMMARY AND CONCLUSIONS

In the area of Camp Lejeune one hundred and two species of arthropods were field-collected, ground, extracted with physiological saline, and the extracts tested in vitro for antibacterial activity against *E. coli* and *S. aureus.* Only two species, both Coleoptera, *T. confusum* and *T. castaneum*, produced inhibition of the screening organisms. Detailed studies on aqueous extracts of *T. castaneum* showed that the extracts of this beetle had strong antibacterial activity in vitro against a wide spectrum of organisms. On the other hand, this extract had no inhibitory action against various fungi tested. Aqueous extracts and extractions made with a variety of organic solvents were found to be equally potent against *E. coli* and *S. aureus*, and gave similar chemical reactions. White mice infected with *D. pneumoniae* failed to show any protective activity attributable to either aqueous or carbon tetrachloride extracts of *T. castaneum* injected intraperitoneally. Chemical studies support the view that the antibacterial substance extractable from *T. castaneum* is, at least in part, a quinone. It is possible that the discovery of only two species showing antibacterial activity was due to limitations in the method of testing; the active antibacterial agent from these two species is readily diffusible through the agar medium in the Petri dish; other species, not showing activity by this method of testing may yet have antibacterial substances not water-soluble or readily diffusible.

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This study of the syetematics and ecology of insects in the nests of birds and rodents is almost unique, so far as tropical faunas are concerned. It attempts to determine the degree of association of commensals, in terms of abundance (l'abondance), constancy (la constance), and fidelity (la fidélité), in the subterranean and aerial nests of mice, rats, squirrels, and flying squirrels, and in the aerial nests of several birds. The systematic part covers the orders Collembola, Psocoptera, Hemiptera, Coleoptera, and Lepidoptera, and includes descriptions of new genera and species.

It is unfortunate that the rodents and birds could not be more positively identified. Only one rodent, *Cricetomys gambianus*, is mentioned by its scientific name, and only one bird, a weaver finch (Ploceus à col long), is given more than a subfamily or generic designation. From the entomological standpoint, the study seems to be quite thorough.—M. T. J.

ON TICKS (IXODIDAE) OF SOUTHERN FRENCH SOMALILAND AND THE REDISCOVERY OF RHIPICEPHALUS LONGICOXATUS NEUMANN 1905[1]

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This brief tick survey of Southern French Somaliland was made in July 1950, during the height of the dry period. What remains of the human population at this season in the torrid, forbidding, sparsely inhabited land is concentrated in the capital, Djibouti, an important seaport and rail terminus and in small outlying oases. Many families have migrated to the Ethiopian highlands with their herds of sheep, goats and cattle in search of grazing and water. The area lies within the Somali Arid District of the Eastern Ethiopian fauna, and gradually rises from sea level desert or semidesert to sparsely vegetated, boulder-strewn foothills, outliers of the Abyssinian highlands, interspersed with salt flats.

Rainfall is less than 10 inches per year, a situation prevailing along the entire East African coastal lowlands from the equator northwards. During winter there is usually enough rain to provide an attractive amount of grass for grazing over much of the country.

Because of the seasonal trek for water and nomadic habits of pastoral tribes, many ticks are brought into French Somaliland from the Ethiopian highlands. Of the 13 species collected, 8 are known or strongly suspected of transmitting one or more human diseases (Hoogstraal 1952), and several species arrive from Ethiopian areas known to be endemic for tick-borne diseases. Tick-infested cattle for slaughter in the Djibouti market arrive daily afoot or by rail from Ethiopia, and the following Djibouti records are for Ethiopian cattle.

A conscientious Medical Service is available, but indigenous inhabitants are still so loathe to take advantage of it that there are no reliable statistics on the incidence of tick-borne diseases among humans. The government veterinarian informed us that tick-borne animal diseases have not been investigated, but that camels frequently succumb in large numbers to "a tick-borne disease."

The trip to French Somaliland was made during a study of ticks of North-East Africa and Arabia in order to compare the fauna from this most southerly continuous extension of the arid[2] northern zone

[1]Research Project NM 005 050.29.03. The opinions and statements contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large.

[2]Less than 10 inches rainfall per annum.

of Africa with that of Egypt and of the northern limits of equatorial African fauna. I was not surprised to find the abundance of ticks in such arid country, for almost nowhere are ticks more common than in reasonably well vegetated stretches of African deserts, but I was impressed with the many more species of common ixodid ticks in Somaliland than in North-East Africa. Proximity to the Ethiopian highlands and nomadic tribal life account for many of these species. It would be of much interest to know which species have actually established themselves in French Somaliland and are thriving under local conditions.

The five collecting stations mentioned below are at the following elevations: Djibouti and Ambouli practically sea level, Ali Sabiet 715 meters, Dikkil 475 meters, Plaine de Haule about 200 meters.

Amblyomma gemma Dönitz 1909

2 ♂♂, sheep; Dikkil. 56 ♂♂, cattle; Djibouti.

Amblyomma variegatum (Fabricius) 1794

24 ♂♂, cattle; Djibouti.

Boophilus (Palpoboophilus) decoloratus Koch 1844

4 ♀♀, cattle, Djibouti.

Hyalomma dromedarii Koch 1844

148 nymphs, 268 ♂♂, 86 ♀♀, camels; Plaine de Haule. 28 ♂♂, 11 ♀♀ sheep; 13 ♂♂, 13 ♀♀ camels; 17 ♂♂, 10 ♀♀, goats; Ali Sabiet. 3 ♂♂, 2 ♀♀ cattle; Djibouti.

Hyalomma excavatum Koch 1844

1 ♂, sheep; 12 nymphs, 1 ♂, 6 ♀♀, camels; Ali Sabiet. 3 ♂♂ cattle, Djibouti. 1 ♂ 1 ♀ gazelle, 5 ♂♂ 3 ♀♀ sheep, 2 ♂♂ goats, Dikkil.

Hyalomma rufipes Koch 1844

1 ♂, 1♀, cattle; Djibouti. 3 ♂♂, 2 ♀♀, sheep; 2 ♂♂, 1♀, camel; Ali Sabiet.

Remarks: Specimens with few hairs in the spiracular area (subspecies *glabrum* Delpy 1949) and others that are typically hirsute (subspecies *rufipes*) are present in this collection. Because of the questionable genetic nature of these varieties outside of the South African Karroo area, Dr. Delpy did not use subspecies names in designating this French Somaliland material sent him for examination, and consequently they are not used here. I have seen similar variation in this species from numerous areas of this species' range.

Hyalomma sp. inquir.

1 ♂, 1♀, sheep; 47 ♂♂, 38 ♀♀, camels; Ali Sabiet.

Remarks: I was unable to identify these specimens and sent them to Dr. L. P. Delpy, the outstanding authority on this difficult genus. His reply, translated, is as follows: . . . "this is most probably a new species (and) investigations based on rearing in the laboratory are indespensable . . . the males can be compared only with *H. savignyi* (G.) and I differentiate them only by characters which can very well be variable. But the females with these males, and with

which they have common characteristics, can be compared only with *H. dromedarii* K. The genital aperture is approximately V-shaped and is not concave. It is even more excavated than in *H. dromedarii*. The rostrum of *H. dromedarii* is shorter, more massive. The only way to reach a certain conclusion is to rear engorged females having V-shaped genital orifice, flat or hollow, and a long-lined capitulum, found with males which are not *H. dromedarii*."

Unfortunately I have been unable to return for living material for rearing but the problem is suggested for anyone able to secure living specimens.

Hyalomma transiens Delpy 1949 (new name and author combination)

3 ♂♂, 1 ♀, sheep; 1 ♂, goat; Ali Sabiet.

Remarks: Delpy (1949) attributes the authorship of this species to Schulze (1919) but goes to say "Nous adoptons le nom *H. transiens* P. Schulze, parce qu'il est courament employé en Afrique du Sud. En réalité, Schulze *n'a jamais décrit l'espèce H. transiens*" (italics mine). Inasmuch as Schulze did little more than write a name under a photograph of what he considered a transient form, and Delpy provided a diagnosis and applied Schulze's same name to a recognizable species, it appears that Delpy should be credited with authorship.

Rhipicephalus evertsi evertsi Neumann 1897

1 ♂, cattle; Djibouti. 10 ♂♂, goats; Dikkil.

Rhipicephalus pravus Dönitz 1910

2 ♂♂, goat; 5 ♂♂, 5 ♀♀, sheep; Ambouli.

Rhipicephalus pulchellus Gerstäcker 1873

1 ♂, camel; 32 ♂♂, sheep and goats; Ali Sabiet. 3 ♂♂, cattle; Djibouti. 1 ♀, goat; Ambouli.

Rhipicephalus sanguineus sanguineus Latreille 1806

5 ♂♂, 4 ♀♀, sheep; 4 ♂♂, 7 ♀♀, goats; 1 ♂, *Lepus* sp.; Dikkil. 1 ♂, sheep; 1 ♂, goat; 1 ♂, camel; Ali Sabiet. 1 ♂, crawling on human, Djibouti.

Rhipicephalus longicoxatus Neumann 1905 (figs. 1–6)

1 ♂, goat; Dikkil. 1 ♂, sheep; Ali Sabiet.

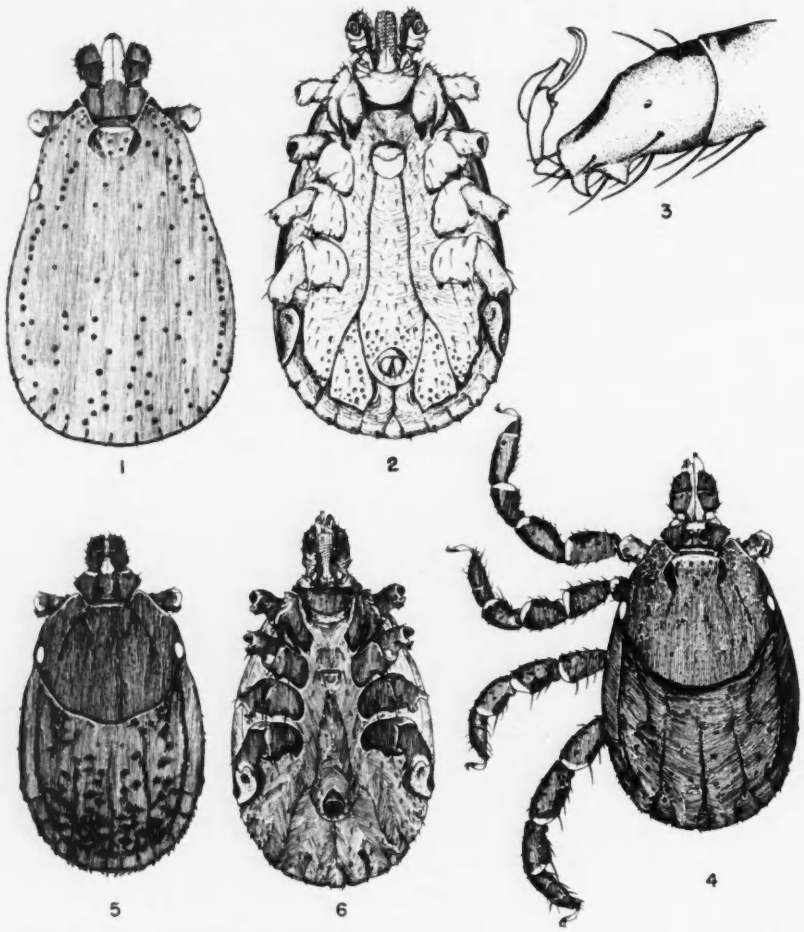
The rediscovery of what appears to be *R. longicoxatus* is of interest. The species has been known from only the unillustrated original description based on a single male and two female specimens from Tanganyika.

MALE

According to Zumpt (1949) the male holotype is now lost. Dönitz's (1907) brief note about the male is discussed below following the description. The two French Somaliland specimens differ slightly from each other. The Ali Sabiet specimen is now in the collection of the Museum of Comparative Zoology, Cambridge, Massachusetts; the Dikkil specimen is in the writer's collection.

Rhipicephalus longicoxatus Neumann 1905. (Original description (translated) with notes on French Somaliland specimens included in italics in parentheses).

"*Male:* Body almost as wide anteriorly as posteriorly, length 4.5 mm. (*Dikkil specimen 3.1 mm.*) not including rostrum, widest, 3 mm., (*Dikkil specimen 2 mm.*) towards middle (*immediately posterior of middle*) of the length. Scutum slightly convex, shiny, reddish-brown, covering entire dorsal face; cervical grooves deep and short, marginal grooves lacking (*indicated only by row of large, deep punctations*); festoons short, with very superficial separations; punctations large, distant, in irregular



Rhipicepalus longicoxatus Neumann 1905. FIG. 1. Male, dorsal, Dikkil,, French Somaliland. FIG. 2. Male, ventral, Dikkil, French Somaliland. FIG. 3. Male, tarsus. FIG. 4. Female No. 1, dorsal, British Somaliland. FIG. 5. Female No. 2, dorsal, Kenya. FIG. 6. Female No. 1, ventral.

lines on the sides, mixed with very numerous very fine almost obsolete punctations (*very few in Dikkil specimen, numerous in Ali Sabiet specimen*); eyes flat, yellowish, large, not quite marginal (*on margin*) on dorsal surface and at a relatively great distance (*commencing one-fifth*

of total distance from anterior end) from the anterior end. Ventral surface reddish yellow, with long and abundant (*sparse, regularly distributed*) hairs; anus at level of anterior third of anal shield (*Dikkil specimen with anus more caudad, due apparently to extension of soft integument*); anal shields strongly punctate, triangular, internal border slightly concave, external subrectangular, the posterior convex and equal to at least half the length of external (*see fig. 2 for anal shield of Dikkil specimen; Ali Sabiet specimen similar except that internoposterior angle is slightly more rounded*); accessory shields short, hardly chitinized, not prolonged caudally. Spiracular plate sub-oval with a straight dorsal prolongation on posterior third of the external border. Rostrum dorsobasally wider than long (*about twice as wide as long*), punctate posteriorly (*only two deep punctations*), lateral angles very salient and towards anterior third of length, cornua broad and slightly salient. Hypostome wide, non-spatulate, with 6 rows of 9 to 11 strong teeth. Palps a little (*one-fifth*) longer than wide, flat dorsally, with parallel borders, not exceeding the hypostome, without lateral projection. Legs strong, thick, the articles feebly punctated. Coxa I with two very long spines, divided almost to the anterior angle (*divided only on distal half*) which is visible dorsally, the external spine triangular, the internal flat, subrectangular; two large, flat teeth on posterior border of other coxae. Tarsi relatively long, with strong terminal spurs."

The Somaliland specimen illustrated here is much smaller than Neumann's original specimen (4.5 mm., original; 3.1 mm., Dikkil). This difference in size may well account for some of the differences noted in our specimens, especially absence of very fine scutal punctations and differences in the anal shields. Neumann's statement that the eyes are at a relatively great distance from the anterior end of the scutum is more difficult to correlate with the Dikkil specimen, although in the Ali Sabiet specimen the eyes are more posterior.

Dönitz (1907), who saw the male type before it was lost, considered this species in the *simus* group, and reported two pairs of scutal grooves, one paramedian pair (but no median groove) and another pair just anterior to these. These "grooves" may have been contractions of the exoskeleton at the point of muscular attachments after death. We may assume that had they been present at the time Neumann described the specimen he would have mentioned them, if only because of the unusual arrangement and absence of the usual median groove.

FEMALE

The female has been known only from the two original unillustrated specimens from Tanganyika. Recently while studying various collections, Dr. Gertrud Theiler of Onderstepoort, Union of South Africa, found two other specimens which she very kindly sent with permission for inclusion here. These are (Specimen number I) a female from a camel at Mandara, British Somaliland, October, 1944, collected by Dr. A. D. Charters, and (Specimen Number II) a female from the ground, arid bush in game country, near Wamba, near Isiola, 4000 feet elevation, Northern Frontier District, Kenya (Onderstepoort Standard Collection number 2789ii). Dr. Theiler has compared the latter specimen with her notes on the paratype specimen now in Dr. F. Zumpt's collection, and finds that this specimen does not differ from these notes.

The two specimens will be returned to Onderstepoort. The original description (translated) is as follows:

"*Female:* Body 12 mm. long, 8 mm. wide, reddish brown; scutum a little longer (2.6 mm.) than wide (2 mm.), the side slightly curved in the posterior third; eyes similar to those of the male, towards the middle of the length of the scutum; cervical grooves deep at their base, wide and superficial later, scarcely passing the anterior level of the eyes; marginal grooves lacking, punctations as in the male. Dorsal and ventral surfaces almost smooth, with fine, distant punctations, genital pore narrow, peritremes similar to those of the male. Rostrum basally twice as wide as long; porose areas deep, oval, separated by twice their length. Palps and hypostome a little longer than in the male, otherwise similar. Legs longer and thinner, with the same characters."

The two specimens at hand conform to the original description, which, together with the illustrations in the present paper, provide a ready identification of this sex. The eyes of the Somaliland specimen are situated on the lateral margin while those of the Kenya specimen are slightly removed from the lateral margin. An exception to the original description is the scutal length, which is no greater than the width, but according to Dr. Theiler this is also true in the paratype she has examined. The scutum of the Somaliland specimen has more and deeper punctations and wider, deeper, and longer cervical grooves than the other.

DIAGNOSIS

A combination of male characters causes this to be a most unique species. Though the scutal punctation is like that of the *simus* group, the prominent dorsal extension of coxa I is like that of the *appendiculatus* group, and the absence of lateral grooves is like the *aurantiacus* group. These features together with the distinctive anal plates, are so different from those of any other known species in a genus where species are often distinguished only with difficulty, that we easily refer our specimens to *longicoxatus* in spite of minor characters differing from those in the original description.

The female is diagnosed by its short, broad, feebly punctated scutum with well developed cervical grooves but lacking lateral grooves, flat eyes, relative width of palps, and shape of rostrum.

I am indebted to Dr. J. Bequaert for first calling my attention to the resemblance between the male specimens and *R. longicoxatus*, to Dr. G. Theiler for female specimens, and to Lt. (j.g.) William Wells, U.S.N. for assistance in collecting the Somaliland specimens.

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HONDURAS PSELAPHIDAE[1]

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From October 1948 to October 1949 the senior author was employed by the Standard Fruit and Steamship Company to investigate the probable association of insects with Panama Disease of bananas in Honduras. In connection with this project, two light traps for collecting insects were operated intermittently at La Ceiba and Coyoles Central from May to September 1949. Few of the insects closely associated with bananas were attracted to the lights, but other insects in large numbers and variety were taken of which small Coleoptera were especially abundant. The staphylinoid family Pselaphidae was well represented in the traps in both individuals and species and is treated systematically in this report.

Most species of Pselaphidae live in vegetable mould where they are predators on small arthropods: springtails, Acarina, insect larvae, and other minute animals. Other species are inhabitants of ant and termite nests. Variation in these ecological areas usually support different species of pselaphids and may account for the generally different composition as noted in the traps from the two areas.

The light traps each consisted of a metal funnel 15 inches high, about 15 inches in diameter at the top, and to the narrow opening was attached a small jar half filled with 70% alcohol. A 200 watt frosted bulb was suspended about six inches above the funnel.

COLLECTION NOTES

Carr (1950), in his classification of animal habitats in Honduras, includes both La Ceiba and Coyoles Central in the Caribbean lowlands topographic division. They are located in the north central part of Honduras, La Ceiba on the Caribbean coast in the Atlantido Department, and Coyoles Central about 50 kilometers southeast of La Ceiba and 12 kilometers west of Olanchito on the Aguan River in the Yoro Department.

Coyoles Central, not to be confused with the village of Coyoles on the edge of the Aguan valley, is the temporary headquarters of the banana plantations. Because of the temporary nature of these plantations in Honduras, this locality is given in the records of pselaphid species as Olanchito although it is about 12 kilometers west of the village. It is

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about 100 kilometers up the Aguan River from the coast, and conditions become more semiarid as one proceeds up the river as evidenced by the more numerous cactus plants and shorter grasses. Coyoles Central is on the edge of the benchland overlooking the present floodplain or vega of the Aguan River. This benchland is level to rolling and is approximately 50 feet above the vega. It is about 2 kilometers wide on each side of the vega. Under normal conditions it is dry and supports several species of cacti which may be found growing from the vega to the higher pine and grass covered foothills above the benchland. But under banana cultivation and irrigated with a total of about 100 inches of water per year, conditions are radically changed. The vega is much richer than the benchland and requires less irrigation for banana production. It averages from one-half to one kilometer in width and often has thick groves of trees and swamps along the river.

At Coyoles Central the light trap was set up at the edge of the village under the overhang of the guest house. Here it could easily attract insects from the floodplain and the benchland for it had little competition with other lights. It was believed to be more effective than the continuously operated La Ceiba light, although it was in operation only from sundown to 10 P. M. and from 4 A. M. to daybreak.

At La Ceiba, the largest coastal town in Honduras, it is less than a mile from the coast into the foothills of the lofty Cangrejal Range. Much of the adjacent area, adequately described by Yuncker (1940), has been cleared, planted with bananas, abandoned, and now is reverted chiefly to pasture. Near the coast the area is dotted with several swamps, especially at the mouths of rivers and larger creeks, and in adjacent sandy places coconut palms are cultivated. The foothills and lower mountainous region are covered by brushy vegetation.

The 80 to 100 inches of rainfall a year at La Ceiba is accompanied by a rapid decay of vegetation and there is produced very little stable plant mould for supporting pselaphids. Also the light trap, although uncovered, was located within the city and competed with other nearby lights as an attractant. It is believed that this light competition factor and the scarcity of vegetable mould may account in part for the smaller number of pselaphids taken at La Ceiba than at Coyoles Central.

Over 600 individual pselaphids were taken in the Becker collections, nearly all from the two light traps but a few from a light globe and elsewhere as noted in the records. The collections represented 12 genera and 38 species. Unless otherwise indicated the records were for 1949.

ACKNOWLEDGMENTS

We are much indebted to Dr. H. H. Ross for his enthusiastic interest in the development of this project, and for his many comments and criticisms. To Dr. Orlando Park of Northwestern University, we owe our thanks for consulting with us on numerous questions and for examining some of the material involved in this study. We have made comparisons with a number of his types and with other material in his extensive Neotropical collection. We have found his many contributions on Neotropical pselaphids indispensable and of great help in our

interpretation of the Honduras collections. We also wish to express our thanks to Dr. Henry Dietrich of Cornell University for the loan of the type male of *Decarthron denticulatum* Fletcher.

STUDY TECHNIQUES

To study pselaphids adequately it is very desirable, and with some individuals necessary, to depart in mounting procedure from the time honored method of gluing these small beetles to cardboard points. Park (1942) emphasized the need for slide mounts for study of minute external and internal structures, and to his recommendation we would add the desirability of studying and preserving collections in alcohol. All of the Honduras material was studied with a binocular microscope with magnifications up to 130 diameters. Representatives of all species were softened and cleared in cold 10% KOH and dismembered as much as necessary in order adequately to examine and illustrate structural details. Manipulation of the structures for greater ease in illustrating and for direct comparisons with other species was found to be more satisfactory in alcohol than dry mounts or slide preparations. However, temporary slide mounts were occasionally made where greater magnifications were desired. The dissected specimens are preserved in very small vials stoppered with cotton.

CHARACTERISTICS

In the systematic treatment to follow, only those genera and species taken in the Becker collections are included. A key is given to the genera without regard to their tribal positions, but the genera are listed elsewhere in this report under their respective tribes as outlined by Park (1942). The generic descriptions are based on the Honduras material and do not necessarily include all of the known features of each genus. Keys are presented to the species in each genus with references to figures illustrating some of the most useful and more readily observable characteristics. Illustrations of the male genitalia, and other features not always included in the keys, are given not only to aid in the recognition of the species but also to contribute to the wealth of useful taxonomic characters for the consideration of students of this family.

Many pselaphids are recognized by their small size, short elytra with distinctly exposed but broad abdomen, and by their conspicuous antennae. The number of antennal segments in the Honduras genera collected ranges from 9 to 11 and often they are strikingly modified and enlarged and frequently show specific differences in one or both sexes. This was especially true throughout the genus *Reichenbachia*. The shape of the head, the presence or absence of dorsal and ventral foveae, carinae, or excavations, offered characters especially of generic value but often for species recognition. The shape of the mandibles and the number of inner marginal teeth were of some generic singificance, and a few species could be recognized by their characteristics. The four-segmented maxillary palpus presents characters of generic significance especially in the relative proportions of the segments, their shapes, grooving of the last segment, and the presence or absence of terminal and lateral appendages.

Very useful generic characters are found in the shape of the pronotum, and the presence or absence of foveae and grooves and their location. The elytron often is provided with basal foveae or punctures, and these together with the extent of the longitudinal dorsal striae, if present, show features of generic and occasionally specific importance. The number and relative proportions of the tarsal segments, sometimes not clearly observed except under very high magnification, are especially useful in the definition of tribes. These characters were not always used in the generic keys but they are mentioned and described in some of the generic diagnoses. However, other leg characters, especially the tibiae, femora, and trochanters revealed many generic and often specific features of importance. Many males of ***Decarthron*** are distinguished by characteristics of the middle femora, these often being intricate in detail.

The abdomen, with the internal genitalia, offers many characters of generic and specific value. It is not always easy to determine the number of sternites in dry mounted individuals but this was easily observed in alcoholic material or with cleared individuals examined in glycerine. Anterior to the first large and easily visible sternite (morphologically the fourth), the third sternite may appear as a narrow transverse structure nearly covered by the metathoracic coxae. Occasionally it is visible only between the coxae or at the sides of the abdomen. In this report the abdominal sternites and tergites are treated in their true morphological arrangement. The first large tergite (morphologically the fourth) posterior to the elytra often has foveae and carinae of generic and specific significance. Succeeding tergites are infrequently modified but the pygidium may present some important features. The abdominal sternites, especially the last one or two, may have external or internal features of specific importance.

The male genitalia of these small beetles have shown excellent species characteristics throughout the Honduras collections. Usually it was necessary to remove only the pygidium, after the abdomen was cleared, for removal of the genital structures. In some genera the genitalia are large and complicated in detail, and in others quite small and simplified. The complicated structures were especially noticeable in the species of *Scalenarthrus*, *Arthmius*, *Reichenbachia*, and to some extent in *Decarthron*. To observe some structures in detail it is necessary to rotate the genitalia to the desired angle. This procedure is not always possible on slide mounts, and argues further for the study and preservation of these small structures in alcohol. The difficulty of homologizing some of the parts was resolved by the liberal use of simple terms such as right and left or median lobes, apical lobe, basal piece, etc. We consider that the aedeagus is probably a membranous intromittent organ and we have therefore avoided the use of this term because of our failure to locate it definitely. It became evident in our studies that no other course was open until future comparative studies can be made of these structures in all available species. At that time their homologies possibly could be established as well as the evolutionary trends within the genus.

The length of the head is considered from the basal constriction to the apex of the labrum and the width includes the eyes, unless otherwise stated.

The types of all new species described in this report are deposited in the collection of the Illinois Natural History Survey, and paratypes are in the collection of Dr. Orlando Park. The type of *Fustiger clavipilis* Mann, the only species previously recorded from Honduras, is in the collection of the United States National Museum.

KEY TO NEOTROPICAL SUBFAMILIES

Antenna with three segments ..... **Clavigerinae**
Antenna with nine, ten or eleven segments ..... **Pselaphinae**

Subfamily **Clavigerinae**

The only previously recorded species of Honduras Pselaphidae was by Mann (1921, p. 551–552, fig. 6) who described *Fustiger clavipilis* on the basis of one female taken at Lombardia with the host ant, *Wasmannia auropunctata* Roger. This pselaphid was placed by Mann in the subfamily Clavigerinae of which the Neotropical genera are distinguished from the Pselaphinae of Park (1942), in which all other known Honduras species are arranged, by the rudimentary mouthparts, and the three segmented antenna. The Neotropical Pselaphinae have well developed mouthparts and the antenna has from 9 to 11 segments.

Subfamily **Pselaphinae**

KEY TO GENERA OF HONDURAS PSELAPHINAE

1. Antenna (figs. 5–7) 9-segmented; tarsus (fig. 11) 2-segmented. . **Bythinoplectus**
   Antenna 10- or 11-segmented; tarsus 3-segmented 2
2. Antenna (figs. 73–76) 10-segmented; ventral surface of head with a median fovea-like excavation near the mentum 3
   Antenna 11-segmented; ventral surface of head without median fovea 4
3. Ventral surface of head with large median fovea-like excavation; fourth segment of maxillary palpus (fig. 85) widest at the middle, then tapering to a subacute apex ..... **Decarthron**
   Ventral surface of head with median carina terminating anteriorly in a small fovea; fourth segment of maxillary palpus (fig. 86) widest near the apex, apex bluntly rounded, ventral margin straight ..... **Drasinus**
4. Pubescence consisting of scales; second, third, and fourth segments of maxillary palpus (fig. 122) each with a slender lateral projection terminated with a group of setae ..... **Ctenisis**
   Pubescence absent or consisting of setae; maxillary palpus without lateral projections 5
5. Last segment of maxillary palpus (figs. 127 and 129) with a sulcus either extending the entire length of the segment or confined to the apical half 6
   Last segment of maxillary palpus without sulcus 7
6. Sulcus of maxillary palpus (fig. 129) extending the entire length of the last segment; middle trochanter short so that the coxa and femur are nearly adjacent ..... **Cercoceroides**
   Sulcus of maxillary palpus (fig. 127) confined to the apical half of the last segment; middle trochanter (fig. 126) long, thus widely separating the coxa and femur ..... **Apharus**
7. Ventral surface of head (fig. 65) with three very distinct acute longitudinal carinae; each elytron without basal foveae, but either with or without four minute punctures replacing the foveae ..... **Scalenarthrus**
   Ventral surface of head never with three very sharp carinae; carinae, if present, rounded and indistinct; each elytron usually with basal foveae ... 8
8. Head (figs. 12 and 13) produced forward with the antennae nearly contiguous on the ventral side near the apex of the projection .... **Rhinoscepsis**
   Head not produced forward, or if so, produced between the antennae as in figs. 114 and 116 9

9. Last segment of antenna (fig. 18) elongate, as long as the third to tenth segments combined ..... **Eupsenius**
   Last segment of antenna not elongate, not longer than seventh to tenth segments combined 10
10. Pronotum (fig. 21) shield-shaped, with transverse basal groove; head (fig. 22) strongly concave on vertex ..... **Actium**
    Pronotum not shield-shaped, without transverse basal groove; head not concave on vertex 11
11. Elytra without basal foveae, instead each elytron with four minute punctures replacing the foveae ..... **Scalenarthrus**
    Elytra with distinct basal foveae as in figs. 44 and 45 12
12. Dorsal stria present on elytron (figs. 44 and 45); pronotum without basal transverse groove; middle coxae (fig. 56) narrowly separated .. **Reichenbachia**
    Dorsal stria absent; pronotum with basal transverse groove; middle coxae distinctly contiguous ..... **Arthmius**

Tribe **Pyxidicerini**

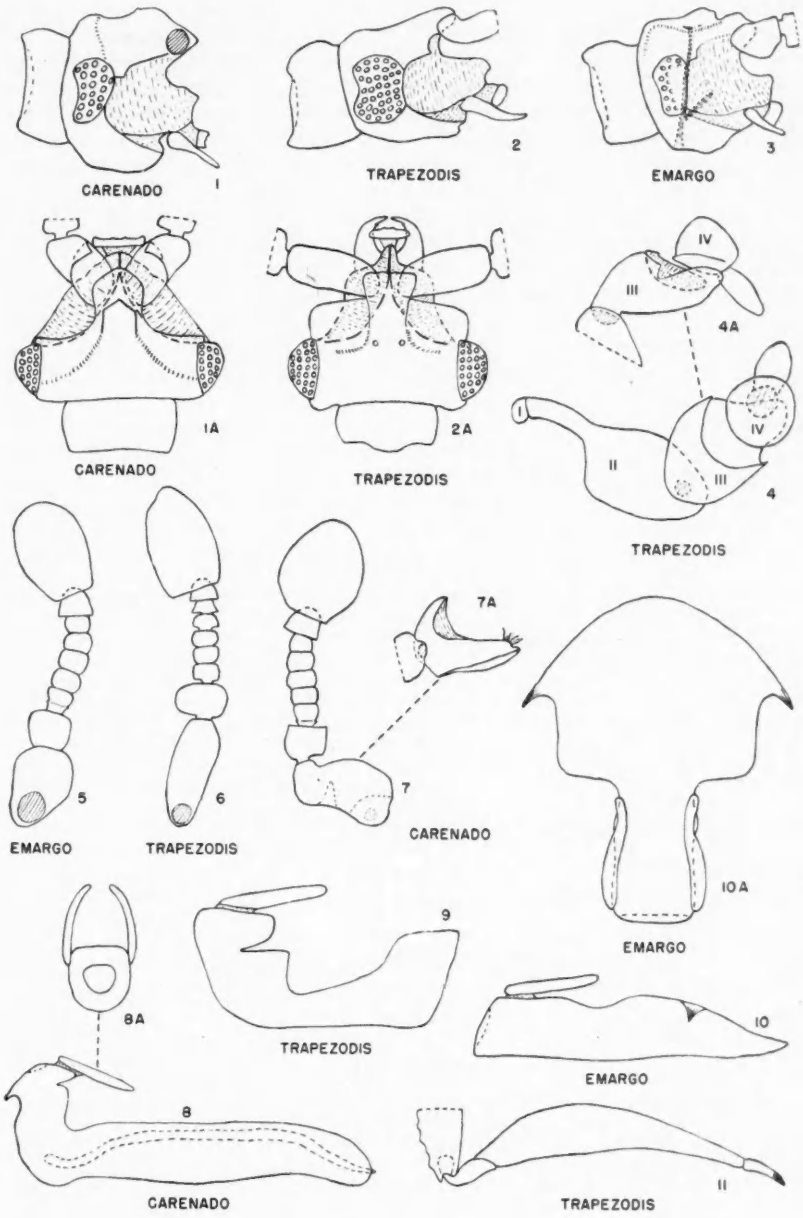
Bythinoplectus Reitter (1881, p. 195)

This small genus is the only representative of the tribe Pyxidicerini in the Western Hemisphere and is readily recognized by the nine-segmented antenna (figs. 5–7), the unusual maxillary palpus (fig. 4), and the two-segmented tarsus (fig. 11). Raffray (1903, p. 489), Park (1942, p. 37) and Jeannel (1949) all have stated that the Pyxidicerini have three tarsal segments, the first small, the second smaller and not visible from the dorsal side of the tarsus, and the third very large. The tarsi of four Honduras specimens representing three species believed to belong to *Bythinoplectus* have been examined on slide mounts with a phase microscope under magnification up to 1455 diameters, and only two segments were noted. Several congeneric unidentified females from Yucatan have also been examined and they have tarsi similar to the Honduras males. Two segments are also clearly visible in alcoholic material magnified to 100 diameters. Possibly previous authors have misinterpreted the number of tarsal segments or we may have examined a different genus. However, it is proposed that other species described as belonging to *Bythinoplectus* should be reexamined critically to determine the number of tarsal segments. If they and other genera of Pyxidicerini, especially the African *Zethopsinus* Jeannel and *Jeannelia* Raffray as defined by Jeannel (1949) actually have a three-segmented tarsus, then the three Honduras species described here may belong to a different genus, or the characteristics of the Tribe Pyxidicerini should be modified to include them.

In addition to sharing the antennal and tarsal features mentioned above, the three Honduras species are similar in their elongate form.

EXPLANATION OF PLATE I

Bythinoplectus, males. FIGS. 1–3. Heads, lateral aspect; A, dorsal aspect.
1. *B. carenado*. 2. *B. trapezodis*. 3. *B. emargo*.
FIG. 4. *B. trapezodis*, right maxillary palpus, dorsal aspect; A, lateral aspect.
FIGS. 5–7. Right antenna. 5. *B. emargo*, dorsal aspect. 6. *B. trapezodis*, dorsal aspect.
7. *B. carenado*, ventral aspect; A, oblique lateral aspect.
FIGS. 8–10. Male genitalia, lateral aspect; A, dorsal aspect. 8. *B. carenado*.
9. *B. trapezodis*. 10. *B. emargo*.
FIG. 11. *B. trapezodis*, right anterior tarsus, lateral aspect.


CARENADO
1
TRAPEZODIS
2
EMARGO
3
1A
CARENADO
2A
TRAPEZODIS
IV
III
4A
I
II
IV
III
4
TRAPEZODIS
5
EMARGO
6
TRAPEZODIS
7A
7
CARENADO
10A
EMARGO
8A
9
TRAPEZODIS
10
EMARGO
8
CARENADO
11
TRAPEZODIS

Apparently they are glabrous except for a few scattered setae. Vertex transverse, rugose; antenna attached to the underside of a prominent tubercle; maxillary palpus (fig. 4) with a small first segment, second very narrow for the basal third, abruptly enlarged to form a large flattened club, third large, elongate, depressed mesally for the reception of the larger lobe of the fourth, fourth subdivided longitudinally at the base into a large and a small lobe; front deeply excavated on each side back to the eye to receive the maxillary palpus in repose; pronotum rugose, with one lateral basal fovea on each side at the posterior edge of a shallow depression, but without a median fovea; each elytron with two basal foveae, entire sutural stria originating from the mesal fovea; posterior coxae contiguous, each produced conically as in fig. 20; middle coxae contiguous; mesosternum with a well defined median rectangular reticulated area just anterior to the coxae; metasternum convex; tarsus (fig. 11) two-segmented, the first segment very small, curved, the second extremely long, about half the length of the tibia, widest at the basal third, tapering to both ends and terminating in a well-developed claw.

Park (1949, p. 318) states that the males of *Bythinoplectus* are easily recognized by having a transverse incision on the head just behind the antennae. This secondary sexual feature was not found in two of the three Honduras species.

KEY TO THE SPECIES (MALES)

1. Antenna (fig. 7) with the first segment modified, deeply excavated dorsally with a recurved laminoid projection at the apical end of the excavation; fourth to sixth tergites each with distinct carinae originating from the basal foveae; genitalia (fig. 8) very long, as long as the last three sternites combined, narrow, apex straight, not turned down..... **carenado**
   Antenna (figs. 5 and 6) with first segment unmodified, either elongate or broad and flattened; fourth to sixth tergites without carinae or with short, indistinct ones; genitalia (figs. 9 and 10) either short or very broad..... 2
2. First antennal segment (fig. 5) broad when viewed from above; small laminoid projection as in fig. 1A anterior to the eye; genitalia (fig. 10A) very broad with an acute projection on each side..... **emargo**
   First antennal segment (fig. 6) elongate, cylindrical; large broad laminoid projection (fig. 2A) anterior to the eye; genitalia (fig. 9) short, narrow, U-shaped with the apex turned down..... **trapezodis**

Bythinoplectus trapezodis n. sp.

Male.—Length nearly 2 mm.; color light brown. Head (fig. 2) slightly longer than wide; vertex flattened with two small foveae quite close together between the anterior margins of the eyes; laminoid pro-

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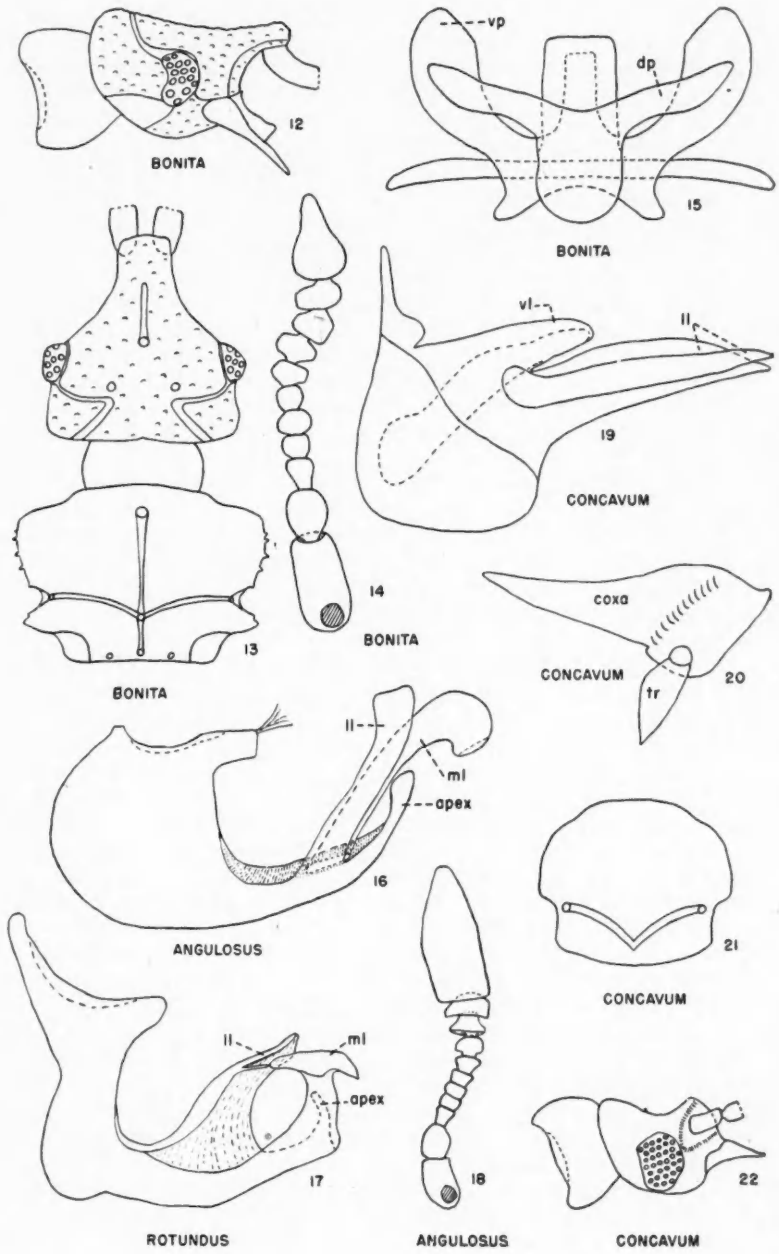
EXPLANATION OF PLATE II

Abbreviations: *dp* = dorsal plate, *ll* = lateral lobe, *ml* = median lobe, *tr* = trochanter, *vl* = ventral lobe, *vp* = ventral plate.

FIG. 12. *Rhinoscepsis bonita*, head, lateral aspect. FIG. 13. *R. bonita*, head and pronotum, dorsal aspect. FIG. 14. *R. bonita*, right antenna, dorsal aspect. FIG. 15. *R. bonita*, male genitalia, dorsal aspect. FIG. 16. *Eupsenius angulosus*, male genitalia, lateral aspect. FIG. 17. *E. rotundus*, male genitalia, lateral aspect. FIG. 18. *E. angulosus*, right antenna, dorsal aspect. FIG. 19. *Actium concavum*, male genitalia, lateral aspect. FIG. 20. *A. concavum*, right posterior coxa, ventral aspect. FIG. 21. *A. concavum*, pronotum, dorsal aspect. FIG. 22. *A. concavum*, head, lateral aspect.


12
BONITA
vp
dp
15
BONITA
vl
II
19
CONCAVUM
14
BONITA
13
BONITA
coxa
CONCAVUM
tr
20
II
ml
apex
16
ANGULOSUS
21
CONCAVUM
II
ml
apex
17
ROTUNDUS
18
ANGULOSUS
22
CONCAVUM

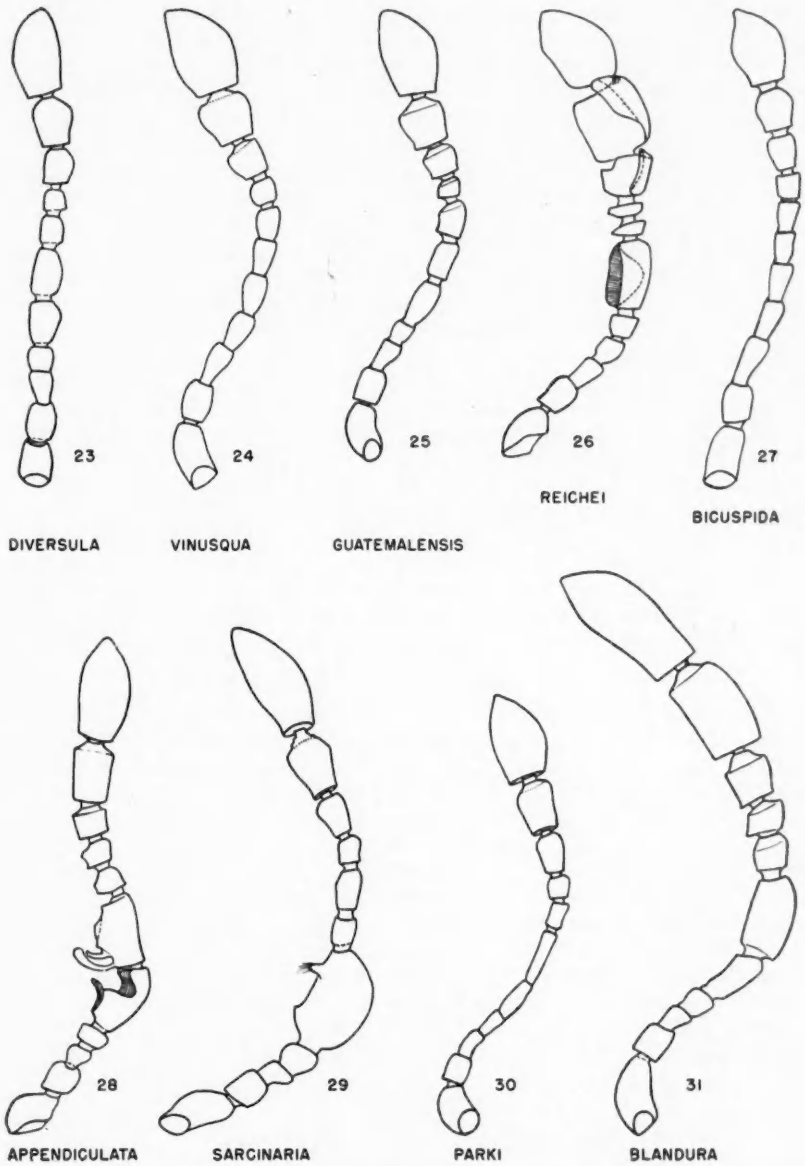
jection extending forward from the eye for a distance equal to the width of one eye and then extending mesad to the base of the antennal tubercle; antennal tubercle prominent. Antenna (fig. 6) with the first segment elongate; second, slightly transverse, wider than the preceding; third to sixth each transverse, one-third the width of the second; seventh transverse, widest at the base with the sides straight; eighth nearly quadrate, widest at the base, rounded at the apex; ninth ovoidal with a concave base fitting over the eighth; apex bluntly rounded. Pronotum subquadrate, widest at the apex; anterior angles acute; three longitudinal carinae, one median, and each lateral one just mesad of the fovea. The fourth to seventh tergites subequal in length, each with a parallel sulcus near each lateral margin; large prominent fovea mesad of the sulcus and near the base, and a broad transverse sulcus suddenly narrowed at each end connecting the foveae; seventh narrowed suddenly on the apical half; eighth rounded at the apex. The fourth to seventh sternites each similar to the tergites, but without the longitudinal sulci and each with a narrow transverse sulcus; eighth narrow. Genitalia (fig. 9) small and simple; U-shaped; base constricted with a mesally curved lateral piece on each side.

Holotype male.—Olanchito, September 8. *Paratype* male, same data as the holotype.

B. trapezodis keys to the female of *denticornis* Raffray (1896a, p. 230) in Park's key (1945, p. 279). The flattened vertex of *trapezodis* will distinguish it from *denticornis* which has a transverse sulcus just behind the antennal tubercle thus dividing the vertex into two parts.

Bythinoplectus carenado n. sp.

Male.—Length nearly 2 mm.; color light brown. Head (fig. 1) nearly quadrate, vertex uneven, convex between the eyes, depressed behind the antennal tubercle; two small inconspicuous vertexal foveae in the depression between the anterior margin of the eyes; narrow laminoid projection just anterior to each eye extending to the ventral surface of the antennal tubercle; antennal tubercle very prominent, elevated considerably above the vertex. Antenna (fig. 7) with a large modified first segment, deeply excavated dorsally with an acute recurved triangular projection at the apical end of the excavation; second segment transverse, produced ventrally; third quadrate, widest at the apex, with a distinct suture and indentation on the basal fourth; fourth to sixth each transverse; seventh transverse, slightly narrower than preceding; eighth quadrate, one-half wider than seventh, widest at the base, apex rounded; ninth ovoidal, base concave, apex rounded. Pronotum slightly wider than long, widest at the apex; sides straight, anterior angles rounded; two adjacent ovoidal depressions between the lateral foveae, shallower elongate median depression anterior to the basal depression. The fourth to sixth tergites subequal in length each with a longitudinal sulcus near each lateral margin, large basal foveae just mesad of the sulcus, a broad transverse sulcus widest on the fourth tergite narrowed abruptly at the ends connecting the foveae, and a curved carina originating at each of the basal fovea and extending posteriorly to the middle of the segment; seventh tergite shorter but similar to the sixth except for a narrow indistinct transverse sulcus,



FIGS. 23–31. *Reichenbachia* spp., right antennae of males. 23. *R. diversula*. 24. *R. vinusqua*. 25. *R. guatemalensis*. 26. *R. reichei*. 27. *R. bicuspida*. 28. *R. appendiculata*. 29. *R. sarcinaria*. 30. *R. parki*. 31. *R. blandura*.

and no carinae; eighth rounded at the apex. The fourth to sixth sternites subequal, each with a large basal fovea near the lateral margin, and an indistinct narrow transverse sulcus connecting the foveae; seventh shorter than preceding with smaller foveae; eighth narrow, rounded at the apex, internally with a long narrow rod-like structure extending from the base of the sternite forward to the base of the sixth sternite; ninth very narrow, divided in the middle. Genitalia (fig. 8) extremely long, nearly as long as the sixth, seventh and eighth sternites combined; tubular, with a long narrow internal lobe; base constricted, with a simple lateral piece on each side.

Holotype male.—Olanchito, June 21.

The distinct suture and identation on the basal fourth of the third antennal segment possibly indicates that the third and fourth segments of a 10-segmented primitive type of antenna fused to make what is now the third segment.

This species is apparently related to *denticornis* and it also shows affinities to *emargo* n. sp. From Raffray's description and illustration (1896a, pl. 10, fig. 16), *denticornis* has a smooth pronotal disc, which is rugose on the sides, and the ninth antennal segment is spherical, and with a slightly acuminate apex. *B. carenado* has the entire pronotum rugose, and the ninth antennal segment is ovoidal with a rounded apex. The modified first segment of the antenna and the evenly rounded antennal tubercle separates this species from *emargo* which has no deep excavation with a recurved projection on the first antennal segment, and the antennal tubercle of *emargo* has a transverse groove. The genitalia of *carenado* and *emargo* are entirely different as illustrated.

Bythinoplectus emargo n. sp.

Male.—Length nearly 2 mm.; color light brown. Head (fig. 3) subquadrate; vertex with two small foveae between the anterior margins of the eyes, separated by the width of the antennal tubercle; narrow laminoid projection just anterior to each eye as in *carenado;* antennal tubercle prominent, elevated above the vertex; deep transverse groove directly above the base of the first antennal segment. Antenna (fig. 5) with the first segment slightly longer than broad, much broader than succeeding segments, gradually thickening towards apex; second transverse, produced ventrally; third to eighth as in *carenado.*; ninth ovoidal, base concave, apex bluntly rounded. Pronotum as in *carenado.* The fourth to seventh abdominal segments as in *carenado,* except the carinae on the tergites are shorter and inconspicuous; eighth tergite with a rounded apex; eighth sternite with an internal median basal chitinous rod extending anteriorly to the base of the seventh

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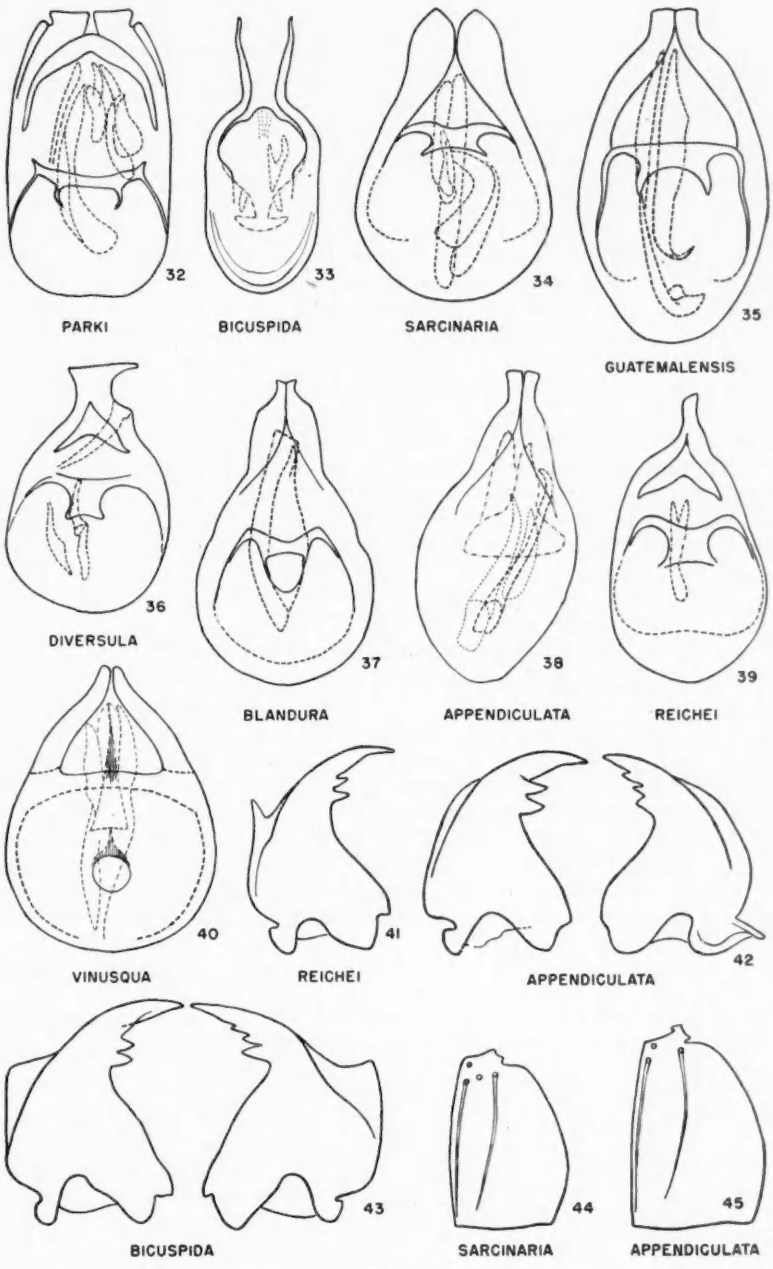
EXPLANATION OF PLATE IV

Reichenbachia spp. FIGS. 32–40. Male genitalia, ventral aspect. 32. *R. parki.* 33. *R. bicuspida.* 34. *R. sarcinaria.* 35. *R. guatemalensis.* 36. *R. diversula.* 37. *R. blandura.* 38. *R. appendiculata.* 39. *R. reichei.* 40. *R. vinusqua.*

FIGS. 41–43. Male mandibles, dorsal aspects. 41. *R. reichei,* left. 42. *R. appendiculata,* right and left. 43. *R. bicuspida,* right and left.

FIGS. 44–45. Male right elytron, dorsal aspect. 44. *R. sarcinaria.* 45. *R. appendiculata.*


32
PARKI
33
BICUSPIDA
34
SARCINARIA
35
GUATEMALENSIS
36
DIVERSULA
37
BLANDURA
38
APPENDICULATA
39
REICHEI
40
VINUSQUA
41
REICHEI
42
APPENDICULATA
43
BICUSPIDA
44
SARCINARIA
45
APPENDICULATA

sternite; apex of eighth sternite emarginate; ninth triangular in shape, divided mesally so that the two short sides are nearly adjacent. Genitalia (fig. 10) very broad with an acute projection on each side; base narrow with a sinuate lateral piece on each side.

Holotype male.—Olanchito, June 21.

B. emargo apparently is most closely related to *impressifrons* Raffray (1896a, p. 230, pl. 10, fig. 15), and *carenado*. From Raffray's description and illustration, *impressifrons* has a triangular impression on each side of the antennal tubercle, and the ninth antennal segment has the apex slightly acuminate. *B. emargo* has no impressions on the sides of the antennal tubercle, and the ninth antennal segment is bluntly rounded at the apex. This species differs from Park's illustration (1945, pl. 3, figs. 2 and 3) of *impressifrons* by *not* having a glabrous triangular area on each side of the antennal tubercle; the seventh antennal segment is slightly narrower than the sixth, eighth one-half wider than the seventh, widest at the base, ninth with a truncate but concave base, and there is no row of setae on the posterior margin of the head behind the eye. Park's illustration of *impressifrons* shows a triangular glabrous area on each side of the antennal tubercle, the sixth, seventh, and eighth antennal segments are each transverse, subequal, ninth with a concave base, when viewed from the side, and there is a row of setae behind the eye. See the discussion under *carenado* for a comparison of these two species.

Tribe **Euplectini**

Rhinoscepsis LeConte (1878, p. 382)

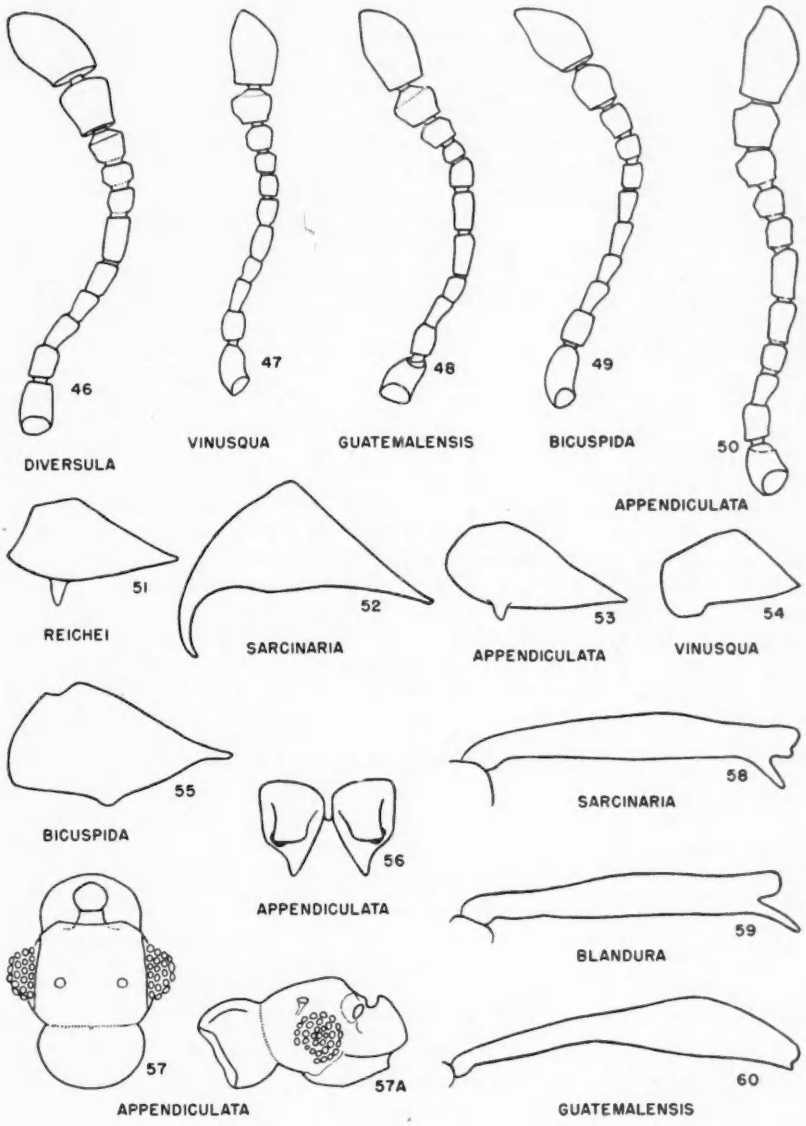
This small genus is in the tribe Euplectini and is distributed mainly in Florida and South America. It is characterized by the conically produced posterior coxae, each elytron has two foveae, and the front of the head is prolonged conically, with the antennae near the apex. The species described here has an undivided eighth sternite thus disagreeing with Park's generic notes (1942, p. 85) in which he states that this is a female character, the males having the eighth (seventh visible) sternite divided into right and left plates. However, the head and pronotum of *bonita* n. sp. are nearly identical to those of *falli* Park (1942 p. 86, pl. 18, fig. 2) and we believe these species are congeneric.

Rhinoscepsis bonita n. sp.

Male.—Length about 1.5 mm.; color brown. Head (figs. 12 and 13) subquadrate; two deep vertexal foveae between the posterior margins of the eyes, a slightly larger median fovea anterior to the vertexal foveae;

EXPLANATION OF PLATE V

Reichenbachia spp. FIGS. 46–50. Female right antennae. 46. *R. diversula*. 47. *R. vinusqua*. 48. *R. guatemalensis*. 49. *R. bicuspida*. 50. *R. appendiculata*. FIGS. 51–55. Male left middle trochanters, ventral aspect. 51. *R. reichei*. 52. *R. sarcinaria*. 53. *R. appendiculata*. 54. *R. vinusqua*. 55. *R. bicuspida*. FIG. 56. *R. appendiculata*, separated middle coxae. FIG. 57. *R. appendiculata*, head, dorsal aspect; A, lateral aspect. FIGS. 58–60. Male left tibiae, lateral aspect. 58. *R. sarcinaria*, middle tibia. 59. *R. blandura*, middle tibia. 60. *R. guatemalensis*, posterior tibia.


46
DIVERSULA
47
VINUSQUA
48
GUATEMALENSIS
49
BICUSPIDA
50
APPENDICULATA
51
REICHEI
52
SARCINARIA
53
APPENDICULATA
54
VINUSQUA
55
BICUSPIDA
56
APPENDICULATA
58
SARCINARIA
59
BLANDURA
57
57A
APPENDICULATA
60
GUATEMALENSIS

a median longitudinal groove running from the median fovea to near the apex of the antennal tubercle; vertex very rugose and warty, with two V-shaped canals extending from near the lateral posterior margins of the vertex inward to about the middle of the head then back to the eyes; antennae borne on the underside near the apex of the prolonged tubercle; eyes small, projecting but little. Antenna (fig. 14) with 1st segment elongate; 2nd elongate, widest at middle; 3rd subquadrate, widest at apex; 4th subquadrate; 5th slightly transverse, distinctly wider than 4th or 6th; 6th subequal to 4th; 7th and 8th each slightly transverse; 9th transverse, larger than 8th; 10th transverse; 11th as long as preceding three segments combined, widest at basal fourth, narrowing sharply to a rounded apex. Pronotum (fig. 13) rugose, transverse, widest at apical fourth; sides deeply emarginate, each with several short spines; three median foveae, two near the base and the largest one near the apex, all connected by a deep longitudinal groove; small lateral foveae at the apex of each side emargination and connected to the middle median fovea by a shallow groove; one lateral basal fovea on each side. Elytra wider than long; each elytron with two basal foveae, one humeral fovea and four apical foveae; the two basal foveae, and the inner two apical foveae as well as the humeral fovea and outer apical fovea each connected with a complete stria. The fourth, fifth and sixth tergites each with parallel grooves near the margins; seventh with groove terminating at the side margin posteriorly; fourth slightly longer than fifth; fifth and sixth each subequal in length; seventh shorter than preceding; eighth emarginate at apex, as long as seventh; pygidium ovoidal, base rounded, lateral margins angulate, apex nearly straight, shallow transverse depression near apex. The fourth to seventh sternites similar to tergites; eighth slightly longer than seventh. Metasternum with a shallow longitudinal median depression. Posterior coxae almost contiguous, each produced conically as in fig. 20, nearly one-half as long as wide. Middle coxae contiguous. Anterior tibia slightly enlarged, evenly convex on dorsal side. Underside of head with a smooth oval depression extending from eye to posterior margin of the head. Genitalia (fig. 15) bilaterally symmetrical, very simple, with only a ventral and a dorsal plate, each plate with lateral lobes and a median lobe; a long narrow transverse rod on the ventral side of genitalia that appears to be the ninth sternite.

Holotype male.—La Ceiba, June 16. *Paratype* male, same data as the holotype.

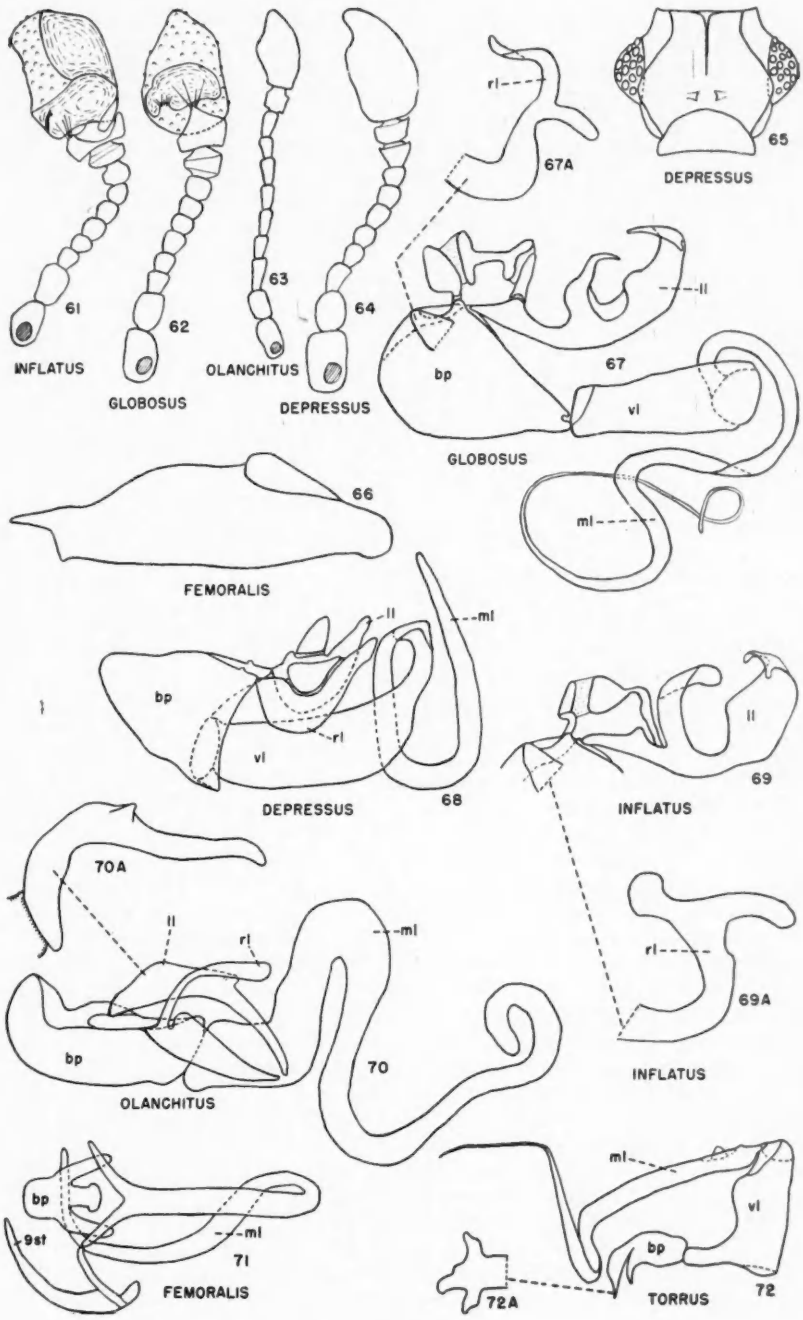
EXPLANATION OF PLATE VI

Scalenarthrus spp. FIGS. 61–64. Right male antennae. 61. *S. inflatus*, mesal aspect. 62. *S. globosus*, mesal aspect. 63. *S. olanchitus*, dorsal aspect. 64. *S. depressus*, dorsal aspect.

FIG. 65. *S. depressus*, head, ventral aspect.

FIG. 66. *S. femoralis*, right anterior femur, lateral aspect.

FIGS. 67–72. Male genitalia; *bp* = basal piece, *ll* = left lobe, *ml* = median lobe, *rl* = right lobe, *vl* = ventral lobe. 67. *S. globosus*, lateral aspect; A, right lobe. 68. *S. depressus*, lateral aspect. 69. *S. inflatus*, left lobe, lateral aspect; A, right lobe. 70. *S. olanchitus*, lateral aspect; A, left lobe. 71. *S. femoralis*, dorsal aspect. 72. *S. torrus*, lateral aspect; A, basal piece.


61
INFLATUS
62
GLOBOSUS
63
OLANCHITUS
64
DEPRESSUS
rl
67A
65
DEPRESSUS
II
67
bp
vl
GLOBOSUS
ml
66
FEMORALIS
II
ml
bp
rl
vl
DEPRESSUS
68
II
69
INFLATUS
70A
II
rl
ml
bp
OLANCHITUS
70
rl
69A
INFLATUS
bp
9st
ml
71
FEMORALIS
ml
vl
bp
72A
TORRUS
72

With regards to the dimensions of the pronotum, ***bonita*** appears to be more closely related to *falli*. It is quite distinct from *falli*, the latter having a long pointed spine on the sixth (third visible) tergite, divided eighth sternite, four basal pronotal foveae, and the dorsal stria extends to the basal third of each elyron. However, Park's illustration (1942, pl. 18, fig. 2) shows only three basal foveae, and the dorsal stria of each elytron extends to the apical fovea. In contrast, ***bonita*** has no spines on any of the abdominal segments and the eighth sternite is not divided. The dorsal stria and basal pronotal foveae of ***bonita*** agree with the illustration by Park but not with his description.

*R. **bonita*** has been compared with Yucatan specimens believed to be ***dybasi*** Park (1942, p. 88). *R. **dybasi*** has a divided eighth sternite, but in ***bonita*** this sternite is entire.

Actium Casey (1886, p. 201)

This genus is a member of the tribe Euplectini and is characterized by the conically produced hind coxae (fig. 20), 11-segmented antenna, two basal pronotal foveae, and two or three basal foveae on each elytron. Most of the species of *Actium* are found north of Mexico. Only four species are found south of the Rio Grande River.

Actium concavum n. sp.

Male.—Length about 1.5 mm.; color light brown. Head (fig. 22) nearly quadrate; vertex depressed with two large subcontiguous excavations between the eyes, each excavation with a foveae at the bottom, and a small conical projection on the posterior mesal side; antennal tubercles prominent; eyes large, projecting but little; ventral surface of head smooth. Antenna with 1st segment short; 2nd slightly elongate; 3rd subquadrate, widest at apex; 4th to 6th each slightly transverse; 3rd to 6th joined closely; 7th to 11th loosely joined and forming an indistinct club; 7th subquadrate, distinctly wider than 6th; 8th subquadrate; 9th and 10th each transverse; 11th elongate, as long as preceding four segments combined, base truncate, apex bluntly rounded. Pronotum (fig. 21) slightly transverse, shield-shaped, sides subparallel for the basal third, suddenly widening and then rounded to the apex; two lateral foveae connected by a curving sulcus. Elytra wider than long; each elytron with three basal foveae, the middle one slightly anterior to the others, and a subhumeral fovea; entire sutural stria originating from innermost basal fovea; dorsal stria originating from outermost basal fovea and extending slightly beyond middle of elytron; entire longitudinal carina originating from subhumeral fovea and paralleling side margin, also a short transverse carina from the same fovea extending half the distance to the outermost basal fovea. The fourth tergite with two longitudinal basal carinae extending one-half the length of tergite and separated by one-third the width of the segment; fourth to eighth tergites each gradually decreasing in length; fourth to seventh each with a sulcus close to and subparallel to side margin. The third sternite visible between the hind coxae as a narrow projection with a mesal blunt recurved hook extending from the middle posteriorly; fourth to seventh sternites gradually decreasing in length;

eighth equal in length to fifth, apex broadly and deeply emarginated; ninth nearly round, covering the genitalia. Posterior coxae (fig. 20) nearly contiguous, conically produced. Metasternum convex with a median longitudinal, broad, shallow depression. Middle coxae contiguous. Prosternum with anterior margin serrate, and with a small longitudinal median carina. Anterior femur with a transverse groove on the ventral surface on the apical three-fourths. Genitalia (fig. 19) with two long pointed lateral lobes, and a shorter, blunt ventral lobe; basal piece rounded and with a ventral projection; internal lobe simple.

Holotype male.—Olanchito, July 30.

A. concavum keys to the Chilean *gracile* Raffray (1898, p. 233) in Park's key (1942, p. 108). From *gracile*, described from a female, this species appears to differ chiefly by the presence of the small projections in the vertexal foveae. *A. concavum* differs from *caviceps* Raffray (1898, p. 234), the only other species known from Central America, by having three instead of two basal elytral foveae.

Tribe **Brachyglutini**

Eupsenius LeConte (1849, p. 90)

This small genus of about ten New World species probably belongs to the tribe Brachyglutini although some authors prefer to place it among the Euplectini. For a discussion of its tribal position, see Park (1942, p. 127). Two Honduras species were collected which agree in the following points: 11-segmented antenna, the last three segments forming a club; ventral surface of the head with a lateral carina running very close to each eye; body glabrous; pronotum without foveae, slightly wider than long, widest at the apical third, sides evenly arcuate for apical three-fourths, base narrower than apex with sides on basal fourth straight and slightly divergent, very shallow arcuate groove which is darker on the basal fourth; each elytron with two basal foveae and a complete sutural stria originating from the mesal fovea; no discal elytral stria; fourth tergite with two very short basal carinae, and a transverse row of punctures on the apical third; fourth sternite with an indistinct transverse row of punctures at middle; posterior coxae conically produced, with a short conical projection arising just anterior to the base of the trochanter; metasternum convex with a broad, very shallow median depression on posterior half; mesosternum with a mesal longitudinal carinoid projection extending forward a short distance from the coxae, another short mesal longitudinal projection at the anterior edge of the mesosternum; anterior femur club-shaped, middle and posterior femora less so.

KEY TO SPECIES

1. Posterior coxae almost contiguous; ventrocaudal angles of the head rounded; eleventh antennal segment as long as third to tenth combined; males and females..... **rotundus**

   Posterior coxae widely separated by a distance equal to the length of the trochanter; ventrocaudal angles of the head acute; eleventh antennal segment as long as all the others combined; males..... **angulosus**

Eupsenius rotundus n. sp.

Male.—Length about 1.5 mm.; color brown. Head subquadrate; two large vertexal foveae; front rounded between the small antennal tubercles; right mandible with small rounded projection on lateral margin about two-thirds the distance from the base; third segment of maxillary palpus without seta on mesal surface. Ventrocaudal angles of the head rounded. Antenna with 1st to 9th segments similar to those of ***angulosus*** (as in fig. 18); 10th segment transverse, widest near the middle, twice as long as 9th, sides straight on basal one-half, cone-shaped on apical half; 11th elongate, twice as long as wide, as long as 3rd to 10th inclusive, sides subparallel for basal half then sloping to a blunt apex. Elytra punctulate on sides, smooth on disc. The fourth tergite as long as fifth and sixth combined; fifth and sixth subequal: seventh longer than sixth; eighth longer than seventh. The fourth sternite longer than fifth to seventh inclusive; fifth to seventh each narrower mesally; fifth and sixth subequal; seventh slightly longer than sixth; eighth cresent-shaped, of equal length throughout. Posterior coxae subcontiguous, but the metasternum does not extend between them. Genitalia (fig. 17) with a wide concave base; basal piece narrow; lateral lobe broad; median lobe broadly flattened at the apex, extreme apex short, cylindrical.

Female.—Differs from the male by the smaller eyes, each about one-half the width of that of the male; tergites similar to those of male; fourth to sixth sternites similar to tergites; seventh sternite as long as sixth at lateral margins, one-half as long mesally; eighth sternite longest mesally, apex nearly straight.

Holotype male.—Olanchito, August 24. *Allotype* female, La Ceiba, August 26. *Paratype* male, Olanchito, July 14.

The closely related Mexican ***gibbicollis*** Raffray (1896a, p. 263) is described as having a very convex pronotum, the head is wider than long, and the last sternite is strongly impressed. The head in ***rotundus*** is subquadrate, and the last sternite is evenly convex and not impressed as described for ***gibbicollis***.

Eupsenius angulosus n. sp.

Male.—Length nearly 2 mm.; color brown. Head subquadrate; two vertexal foveae between the eyes; front carinated between the bases of the antennae, slightly overlapping the rest of the front; third segment of maxillary palpus with a long seta on the mesal surface. Ventrocaudal angles of the head acute, prominent. Antenna (fig. 18) with 1st segment large, elongate; 2nd elongate, as wide as 1st; 3rd elongate, half as wide as 2nd, widest at apex; 4th to 6th each transverse, subequaal; 7th quadrate, slightly wider than preceding, widest at base; 11th elongate, as long as 3rd to 10th combined, 2.5 times as long as wide, base truncate, sides parallel for the basal half, apical half cone-shaped with a slightly blunt apex. Elytra smooth. The fourth tergite long, as long as fifth and sixth combined; fifth and sixth subequal, each with an indistinct transverse row of punctures in the middle; seventh slightly longer than sixth; eighth rounded at apex. The fourth sternite with four basal foveae, two near the meson and

one between the meson and each lateral margin; a basal carina just at the outer edge of each lateral fovea extending one-half the length of sternite; fifth and sixth each shorter than preceding; seventh narrowed mesally, shorter than sixth mesally; eighth as long as fifth, the same length throughout, cresent shape; ninth as wide as eighth, one-half longer, divided into three pieces which are joined closely, the center piece pear-shaped with the narrow end anterior. Hind coxae widely separated, separated by a distance subequal to the length of the trochanter. Genitalia (fig. 16) with large bulbous basal piece; apex broad and flattened; median lobe arising on the apical third, curved upward with a circular opening at the apex; a broad flat lateral lobe arising to the right of the median lobe.

Holotype male.—Olanchito, July 19.

Apparently this species is not closely related to any other known ***Eupsenius*** because of the widely separated posterior coxae, the presence of a seta on the third segment of the maxillary palpus, and the acute ventrocaudal angles of the head.

Reichenbachia Leach (1826, p. 451)

This is the largest known genus of the tribe Brachyglutini and the family Pselaphidae. More than three hundred species of ***Reichenbachia*** have been described for the world, and about eighty species are known to occur in Central and South America. Nine of these have been taken at La Ceiba and Olanchito in Honduras.

Raffray (1904, p. 153) subdivided the genus into 63 groups based in large part on the presence of two or three vertexal foveae, "normal" or "abnormal" antennae, with various modifications of the abnormal types, "normal" or "abnormal" femora or tibiae, two or three basal elytral foveae, a "normal" or "abnormal" vertex of the head, the relative length of the discal elytral stria, and the relative length of the dorsal abdominal carinae. Park (1942, p. 136) used these divisions for the Neotropical species, but later (1945a, p. 381–387) he keyed the Mexican and Guatemalan species without alluding to their group positions in the key. We have followed the latter course in the treatment of the Honduras species, believing this will facilitate identification and aid in the recognition of more natural affinities among the species.

Jeannel (1949) described the new genus ***Trissemus*** to include African species of the old genus ***Reichenbachia*** having three basal elytral foveae, and always with sexual differences in the antennae. No American species of ***Reichenbachia*** were definitely included in ***Trissemus*** but it was inferred that part of our species should go there. Two of the four Honduras trifoveate species show little sexual differences in the antenna, indicating either that this feature is weak as a generic character, or that Jeannel's definition included only African species. It is proposed to retain all of the Honduras components within ***Reichenbachia*** with the suggestion that the trifoveate and bifoveate elytral groups may represent separate phyletic lines but at the same time show much homogeneity in antennal, genital, mandibular, and other characters.

The genus ***Reichenbachia*** is well characterized in the Pselaphidae, always having two or three vertexal foveae, 11-segmented antenna, a

median longitudinal carina or ridge on the ventral surface of the head, three antebasal pronotal foveae with the median fovea smaller than the two lateral ones. Each elytron bears two or three clearly visible basal foveae, and in addition a smaller one near the scutellum partly or entirely covered by the posterior margin of the pronotum. This is readily visible in individuals cleared in KOH or preserved in alcohol. It is not considered in the designations of the elytral foveae. The first fovea is located at the base of a long stria paralleling the elytral suture and is designated the sutural stria fovea. Laterad of the sutural stria fovea is another at the base of a short or long curved discal stria, and this is designated the discal stria fovea. These two foveae were found in all of the Honduras species. In five of the species an additional fovea is situated on a line between the sutural stria fovea and the discal stria fovea, and is designated the median fovea.

All individuals of two species studied, ***appendiculata*** Raffray (1904, 174) and ***bicuspida*** Park (1945a, p. 368) had only two vertexal foveae, but one individual of ***parki*** n. sp., normally with three vertexal foveae, had the anterior fovea absent. Park (1945a, p. 345) mentions this condition as occurring also in ***dampfi*** Park (1945a, p. 377), the subspecies ***obsoleta*** Park (1945a, p. 380) having no frontal fovea. The apparent variability of this fovea argues against its consideration as a phylogenetic character, or as a basis for any major subdivisions of the genus.

Specific characters of importance and easy recognition were found especially in the antennae of both sexes, the male middle coxae and trochanters, and the mandibles. The left mandible of the male is invariably two-toothed on the inside margin, and the right mandible three-toothed, but the outer margin of the mandible is evenly rounded to acutely toothed. Distinctive specific characteristics were also found in the male genitalia. It was often difficult, however, to distinguish the sexes among species with poorly marked secondary sexual characters, and it was necessary to clear some individuals before the sex could be determined.

KEY TO SPECIES

1. Antenna (figs. 23–31) usually with one or more of intermediate or apical segments suddenly wider and longer than adjacent segments, often toothed, excavated, foveate or otherwise modified; intermediate trochanter (figs. 51–55) often toothed; genitalia (figs. 32–40) having a large rounded basal piece, and with sides rounded, tapering, or constricted to a single or divided apex; males 2
   Antenna (figs. 46–50) with intermediate segments not suddenly enlarged but often longer than adjacent segments; intermediate trochanter untoothed; genitalia not as above; females 10
2. Each elytron (fig. 45) with two basal foveae 3
   Each elytron (fig. 44) with three foveae 6
3. Vertex of head (fig. 57) with two foveae situated between eyes 4
   Vertex of head with three foveae, two situated between eyes, and one between antennal bases 5
4. Clypeus (figs. 57 and 57A) strongly raised on disc; middle coxa (fig. 56) with a long internal spine; middle trochanter (fig. 53) with a short marginal spine; fifth and sixth antennal segments (fig. 28) larger than adjacent segments and with internal appendages ..... **appendiculata**
   Clypeus nearly evenly convex; middle coxa simple, without spine; middle trochanter (fig. 55) angulate; fifth and sixth antennal segments (fig. 27) subequal in width to adjacent segments ..... **bicuspida**

5. Antenna (fig. 30) with segments 3 to 7 narrow, the sixth segment about four times longer than wide; middle trochanter evenly rounded on posterior margin ..... **parki**
   Antenna (fig. 24) with segments 3 to 7 broad, the sixth less than twice as long as wide; middle trochanter (fig. 54) with inner posterior margin subtruncate ..... **vinusqua**
6. Fifth antennal segment (fig. 29) much larger than the fourth and sixth; middle trochanter (fig. 52) with a large curved basal process; mandible slightly angulate along lateral margin ..... **sarcinaria**
   Fifth antennal segment not conspicuously larger than fourth and sixth segments; middle trochanter unmodified along posterior margin or with a short spine as in fig. 53; mandible distinctly angulate on lateral margin as in fig. 41 7
7. Antennal segments 6, 9, and 10 deeply excavated on mesal surfaces (fig. 26); middle trochanter (fig. 51) with a short spine on posterior margin ... **reichei**
   Antennal segments rounded or flattened on mesal surface but not excavated; middle trochanter with or without a short spine on posterior margin 8
8. Antennal segments 5 and 6 each conspicuously longer than 4 or 7 as in figs. 23 and 31 9
   Antennal segment 5 longer and wider than 4 or 6, the sixth segment a little longer than seventh (fig. 25) ..... **guatemalensis**
9. Fifth antennal segment (fig. 31) twice as long as fourth, sixth a little longer and wider than fifth; last two segments very large, nearly equal to five preceding combined; middle trochanter without a spine or process on posterior margin ..... **blandura**
   Fifth antennal segment (fig. 23) about one-third longer than fourth; sixth slightly longer than fifth; last two segments gradually larger and slightly less than combined length of preceding four segments ..... **diversula**
10. Vertex of head with two foveae; two basal elytral foveae 11
    Vertex of head with three foveae; two or three basal elytral foveae 12
11. Antennal segments 3, 4, and 5 elongate, about equal in length, the sixth and seventh segments not as long (fig. 49) ..... **bicuspida**
    Fifth antennal segment about one-half longer than fourth (fig. 50) ..... **appendiculata**
12. Two basal elytral foveae; discal stria of elytron extending slightly beyond middle of elytron; antenna as in fig. 47 ..... **vinusqua**
    Three basal elytral foveae 13
13. Discal elytral stria extending a little posterior to middle of elytron; fifth antennal segment (fig. 46) shorter than sixth ..... **diversula**
    Discal elytral stria extending nearly to inner apical angle of elytron; fifth antennal segment slightly longer than sixth (fig. 48) ..... **guatemalensis**

Reichenbachia appendiculata Raffray

Reichenbachia appendiculata Raffray (1904, p. 174).

The identification of our Honduras material with this species is based on comparison with the original description and illustrations of the male antenna by Raffray, subsequent descriptive information and illustrations by Park (1945a, pl. 3, fig. 1), and specimens believed to be this species in the collection of Dr. Park. We have also compared our material with the type of the very closely similar *stroheckeri* Park, described from Panama (1942, p. 149). The latter was subsequently reduced to a subspecies of *appendiculata* by Park (1945a, p. 373).

Males of *appendiculata* are readily recognized by the peculiar development of the fifth and sixth antennal segments (fig. 28). Each elytron (fig. 45) has two basal foveae, and the vertex of the head (fig. 57) is bifoveate. The front margin of the head is subtruncate, and the clypeo-frontal region is deeply transversely grooved in front of a prominent clypeal tubercle. The inner margin of the middle coxa (fig. 56) is strongly angularly produced posteriorly, and the middle

trochanter (fig. 53) has a short tooth on the posterior margin. Each mandible (fig. 42) is evenly rounded on the lateral margin. The male genitalia (fig. 38) consists primarily of the two apically appressed lateral lobes, and five heavily sclerotized internal structures. The three slender more basal processes curve to the left with the ventral process strongly hooked at apex.

In the Honduras collections were several females which we believe belong to this species, and since this sex was previously undescribed, some notes may help with its recognition. It has two vertexal foveae and two basal elytral foveae as in the male. In these features it is similar to ***bicuspida*** Park but differs from the female of that species especially in the antenna (fig. 50), the fifth segment being about as long as the third and fourth combined.

Distribution.—This species was previously recorded from Vera Cruz and Campeche in Mexico (Park, 1945a, p. 373). La Ceiba: June 7 (3♀), June 12 (1♀), June 24 (1♂), June 27 (1♂). Olanchito: June 21 (2♂), September 8 (3♂).

Reichenbachia bicuspida Park

Reichenbachia bicuspida Park (1945a, p. 368).

This was the most abundant species of *Reichenbachia* in the Honduras collections, a total of 72 individuals, equally divided between the sexes, having been collected. Among the known Honduras species it appears to be more closely related to ***appendiculata*** Raffray, having but two vertexal foveae, and two basal elytral foveae. The male of ***bicuspida*** differs from that of ***appendiculata*** by its simple type of antenna (fig. 27), the angulate lateral margins of the mandibles (fig. 43), and by the position of the angulation of the middle trochanter (fig. 55). In ***bicuspida*** the angulation is located about half way between the base and apex of the trochanter and varies from a slight swelling, as illustrated, to one nearly as well developed as the more basal tooth in ***appendiculata*** (fig. 53). The male antenna is very similar to that of the Mexican ***bifoveata*** Fletcher (1928, p. 216, fig. 10), but the species differs from ***bifoveata*** by having marginal mandibular teeth. The male genitalia (fig. 33) have slender, well separated lateral lobes, and a bifid internal structure.

The female of ***bicuspida***, previously undescribed, is nearly similar to the male in antennal characteristics (fig. 49), but it does not have the mandibles angulate. It is somewhat like the female of ***appendiculata*** but in that species the fifth antennal segment (fig. 50) is as long as the third and fourth combined.

Distribution. Originally this species was described from one male collected in Guatemala, and subsequently it was recorded by Park (1948, p. 184) from Guerrero in Mexico. La Ceiba: October 17, 1948 (1♂, 3♀), October 20, 1948 (2♂, 2♀), both collections taken by sweeping, May 26 (1♂), May 27 (2♀), May 28 (1♀), May 29 (2♂), May 30 (1♂), June 1 (1♀), June 2 (2♂), June 6 (1♂), June 7 (4♂, 2♀), June 10 (1♂), June 11 (1♂), June 16 (2♂, 2♀), June 17 (1♂), June 26 (1♂, 1♀), June 27 (2♂, 1♀), August 26 (1♂, 2♀), August 28 (1♂, 1♀). Olanchito: October 7, 1948 (1♂, 1♀) in light globe, June 20 (1♂), June 21 (3♂, 7♀), July 14 (1♂), July 30 (4♂, 11♀), September 8 (1♂).

Reichenbachia parki n. sp.

Male.—Length 1.5 mm. Length of head from antennal bases to cervical constriction subequal in length to width between eyes; vertex of head slightly but evenly convex, unmodified except for a pair of small foveae between eyes; front evenly continuous with vertex and with a small fovea in a slight but broad depression. Mandibles with lateral margins nearly evenly curved, untoothed, but each with a slight prominence near lateral margin. Antenna (fig. 30) slender in basal half, the last four segments gradually enlarged; second nearly as broad as the first, about one-fourth longer than wide; third about twice as long as wide, two-thirds width of second, about equal in length to second, convex on inner margin; fourth subequal in length to third, slightly narrower; fifth nearly twice as long as fourth, about four times longer than wide, a little broader than fourth or sixth at their bases; sixth a little longer than fifth, slightly and gradually enlarged to apex; seventh and eighth each about half the length of sixth, the eighth wider than seventh; remainder of segments enlarged and together forming a club. Pronotum about one-sixth wider than long, shining and very finely punctured, and with very short erect hairs; basal fovea very small, the lateral foveae a little larger, all foveae rounded. Elytron unpunctured, with two basal foveae (as in fig. 45) and a smaller fovea cephalad of the sutural one; discal stria extending nearly to apex of elytron. The fourth abdominal tergite with two short slightly divergent basal carinae, each about one-sixth length of tergite, the two separated by about two-fifths the width of the tergite; sternites all evenly convex, the last also convex, not at all depressed. Middle coxa with a long inner process (as in fig. 56); middle trochanter with posterior margin evenly rounded; middle tibia with a very short inconspicuous apical spur. Genitalia (fig. 32) having each clasper broad and truncate at apex; six internal rods or processes on copulatory sac.

Holotype male.—Olanchito, June 21. *Paratypes*, 5 males, Olanchito: June 20 (2), June 21 (2), July 30 (1).

This species is named in honor of Dr. Orlando Park who has contributed much to our knowledge of Neotropical Pselaphidae and whose works were of very great value in our study of the Honduras collections.

Five of the six males studied each have a small anterior frontal fovea in addition to the two larger ones between the eyes, but one individual, collected June 20, has no frontal fovea. In all other features it agrees with the other males.

On the basis of a trifoveate vertex and front, two basal elytral foveae, smooth body, and not unusually developed legs and antennae, this species falls in Raffray's group 20 (Park, 1942, p. 137). It differs notably from the three species of that group by its convex rather than depressed last sternite. In Park's key (1945a, p. 381) to the male *Reichenbachia* of Guatemala and Mexico, it keys to *juxtairrita* Park. The latter species, described and illustrated by Park (1945a, pl. 9, fig. 6), shows the fifth antennal segment about twice as long as wide, but in *parki* this segment is about four times longer than wide. The individual male with but two vertexal foveae keys to Raffray's group 54 (Park, 1942, p. 138), and in Park's revision of that group (1946, p. 502) it appears to approach *pacifica* Park (1945a, p. 368) known only from the female.

Reichenbachia vinusqua Park

Reichenbachia vinusqua Park (1945a, p. 348).

The type male has been examined and differs from the few Honduras males studied by appearing to have the length and width of the sixth antennal segment subequal, and not distinctly longer than wide as shown in fig. 24. These slight differences may be more apparent than real since the Honduras males were studied in alcohol, with adequate extension of the intersegmental membranes, and the type is a dry mount.

Among the known Honduras species ***vinusqua*** is easily distinguished by the truncate process on the posterior margin of the middle trochanter of the male (fig. 54). The other species have the trochanter unmodified or provided with a curved or toothed process as in figs. 51 to 53. The three vertexal foveae, two basal elytral foveae, and the evenly rounded lateral margins of the mandibles associate ***vinusqua*** with ***parki***. The male is distinguished from ***parki*** by the length and proportions of the antennal segments (fig. 24), the discal elytral stria extends slightly beyond the middle of the elytron and not nearly to the apex as in ***parki***, the middle coxa does not have the inner process of ***parki***, as in fig. 56, and the middle trochanter is not unmodified as in that species. The male genitalia (fig. 40) have the lateral lobes separated at apexes, each narrowly separately rounded.

The female, previously undescribed, is readily distinguished from the known females of other Honduras species by the combination of a trifoveate vertex and two basal elytral foveae. The antenna (fig. 47) is nearly like that of the male but is notably different by having the fourth segment conspicuously shorter than the third or fifth.

Distribution. The type male was taken at light in November at Suchiate, Chiapas, Mexico. La Ceiba: May 28 (1♂), June 2 (1♀), June 7 (1♂), June 24 (1♂).

Reichenbachia sarcinaria (Schaufuss)

Bryaxis sarcinaria Schaufuss (1887, p. 127).

A single male was found in the Honduras collections that agreed with Raffray's illustration (1904, fig. 65) of the peculiar antenna, and Park's illustration (1945a, pl. 2, figs. 6–10) of the antenna, middle trochanter, and middle tibia. The fifth antennal segment (fig. 29) is many times larger than the fourth or sixth, and bears two teeth on the mesal surface. The lower tooth is shorter than the upper. The upper tooth is shown as very long in Park's figure, which was made from a dry mount, but in the Honduras male preserved in alcohol, the short tooth bears a tuft of hair. Possibly the Park example may have had this group of hairs agglutinated so that it could have resembled an extension of the upper tooth. The trochanter of the middle leg (fig. 52) has a long outwardly curved process near the base. The tibia of the middle leg (fig. 58) has a large subapical process set at nearly a right angle to the tibial surface. In addition to this combination of features, the vertex of the head is provided with three distinct foveae, and each elytron (fig. 44) has three basal foveae in addition to the small fovea covered by the pronotum. The male mandibles are similar to those of ***appendiculata*** (fig. 42) but each lateral margin is slightly more

angulate. The male genitalia (fig. 34) have the lateral lobes separated at their apexes, and each is enlarged and somewhat pointed apically. There are five internal copulatory processes as shown in the illustration.

Although not too closely related to any of the known Honduras species, apparently it is closest to those which have three vertexal foveae and three basal elytral foveae.

Distribution. This species was described from Yucatan, Mexico, and has since been recorded by Park (1945a, p. 350) from Oaxaca in Mexico. La Ceiba: June 11 (1♂).

Reichenbachia reichei (Schaufuss)

Bryaxis reichei Schaufuss (1872, p. 264).

The unusual male antennal features (fig. 26) will readily distinguish this species from all others known from Honduras. All of the segments from the 6th to the 10th are foveate, grooved, or flattened. The head is trifoveate, the anterior fovea being shallow but distinct and situated on the frontal declivity between the antennal bases. The middle trochanter (fig. 51) has a short tooth on the posterior margin, and all of the legs are simple with no unusual swellings or other features. The left mandible (fig. 41) has a long lateral marginal tooth. The male genitalia (fig. 39) are the least complicated among the Honduras species studied and is rather unusual by having the lateral lobes completely joined into a single slender process. In this feature it is somewhat similar to *diversula* Raffray (1904, p. 363) but the genitalia of the latter species (fig. 36) have the apex strongly flared. There are also internal structural differences as shown in the figures.

Distribution. Originally this species was described from Colombia and Guatemala, and has been recorded by Park (1944, p. 240; 1945a, p. 365; 1948, p. 183) from Chiapas, Michoacan, Morelos, and Guerrero in Mexico. Olanchito: July 30 (2♂), September 8 (1♂).

Reichenbachia guatemalensis Fletcher

Reichenbachia guatemalensis Fletcher (1928, p. 214).

The rather unusually swollen posterior male tibia (fig. 60) places this species in group 47 of Park (1942, p. 136). The Honduras material studied agrees with Fletcher's illustration (1928, fig. 6) of the male antenna, and with Park's illustration (1945a, pl. 8, figs. 1 and 6) of the male posterior tibia and mandible. Both mandibles are simply angulate similar to the left mandible of *bicuspida* (fig. 43), each elytron is trifoveate, and each middle tibia has a short rather blunt apical spur. The middle trochanter has a simple posterior margin but the coxa is prolonged on the inner margin as in fig. 56. These features, in addition to the trifoveate vertex, appear to isolate *guatemalensis* from any close relationships to other Honduras species, but the simple type of male genitalia (fig. 35), having only three internal processes on the copulatory sac, is somewhat like that of *blandura* n. sp. These two species differ strikingly in antennal features as shown in figs. 25 and 31. The female of *guatemalensis* is closely similar to *diversula* but differs chiefly in its longer fifth antennal segment (fig. 48) when this segment is compared with the sixth.

Distribution. Fletcher described this species on the basis of two males and one female from San Francisco and San Miguel, Lake Peten, Guatemala. Park (1945a, p. 357) subsequently recorded it from Vera Cruz, Oaxaca, and Tabasco in Mexico. La Ceiba: June 7 (2♂, 1♀), June 10 (3♂), June 11 (1♂), June 13 (2♂), August 26 (1♂). Olanchito: June 4 (1♂).

Reichenbachia blandura n. sp.

Male.—Length 1.5 mm. Length of head from antennal bases to cervical constriction equal in length to width between eyes; vertex of head convex, with three foveae; front rather suddenly declivous to the labrum. Mandible acutely toothed on lateral margin as in fig. 41. Antenna (fig. 31) with 5th, 6th, 10th, and 11th segments each suddenly elongated and enlarged, 2nd segment nearly quadrate, 3rd and 4th each shorter than second, wider at apex, 5th twice as wide as long and longer than combined length of 3rd and 4th; 6th a little longer than 5th and 1.5 times its width; 7th and 8th segments each with length and width subequal, their inner margins shorter than outer margins; 9th wider than 8th and forming part of club; 10th twice as long as 9th, shorter than 11th but fully as wide. Prontum slightly wider than long, shining, very finely punctured, with short erect hairs; foveae rounded. Elytron shining, extremely finely punctured, with three basal foveae (as in fig. 44) and a small fovea cephalad of the sutural one; discal stria extending to apical fifth of elytron. The fourth abdominal tergite with two short very slightly diverging carinae, each about one-fourth length of tergite, the two separated by about two-fifths width of tergite; last sternite slightly flattened, the remainder evenly convex. Middle coxa with a long tooth as in fig. 56; middle trochanter with a short slender spine as in fig. 51; middle tibia (fig. 59) with a long subapical spur extending beyond apex of tibia. Posterior tibia slender in basal half, the apical half rather gradually enlarged. Genitalia (fig. 37) with apex truncate, and curved in lateral view; apparently three internal processes.

Holotype male.—Olanchito, October 7, 1948, in light globe.

In Park's key (1942, p. 136) to the Neotropical groups of *Reichenbachia*, this species keys to the couplet for groups 6 and 9, based upon a "normal" antenna. Group 6 has the abdominal carina of the fourth tergite at least one-half the length of the tergite, and group 9 has the carina not more than one-fifth its length. In *blandura* the carina is about one-fourth the length of the tergite. If the posterior tibia of of *blandura* is considered "normal", the species keys to group 35 (Park, 1942, p. 138). It appears closest to *vincentiana* Raffray (1904, p. 169) known only from the West Indies, but in that species the 10th antennal segment is described as square. If the posterior tibia of *blandura* is considered "abnormal" by virture of the enlarged apical one-half, the species would be placed in group 47 containing two species. It has the acute marginal mandibular tooth of *latipes* Fletcher (1928, p. 212) as illustrated by Park (1942, pl. 16, fig. 2) but does not have the posterior tibia triangularly swollen as illustrated by Fletcher (1928, fig. 29). The tibia is nearer that of *guatemalensis* Fletcher, but the lateral mandibular tooth in *blandura* is acute and not obtuse as illustrated for that species by Park (1942, pl. 8, fig. 6).

Reichenbachia diversula (Raffray)

Bryaxis diversa Sharp (March, 1887, p. 29).
Bryaxis diversula Raffray (1904, p. 363). New name for *diversa* Sharp, not *diversa* Raffray (Jan., 1887).

Among the known Honduras species of this genus, ***diversula*** appears to be most closely related to ***guatemalensis*** and ***blandura***, with them having no very striking male antennal modifications. In common with those species the elytron has three basal foveae and the vertex of the head is trifoveate. The discal elytral stria extends a little beyond the middle of the elytron. The middle coxa has a long flat projection, somewhat as in fig. 56, and the middle trochanter has a small spine as in fig. 53. In this latter feature it differs from ***blandura*** which has a simple middle trochanter. The male antenna (fig. 23) differs notably from that of ***blandura*** (fig. 31) by the less suddenly enlarged apical segments. The male genitalia (fig. 36) have the two lateral lobes coalesced at apex with the apex truncate and one outer angle more prolonged than the opposite one. The fifth antennal segment of the female (fig. 46) is shorter than the sixth and not longer as in the female of ***guatemalensis***.

Distribution. This species was described from Panama and has since been recorded and redescribed by Park (1945, p. 361) from several localities in Oaxaca, Mexico. Olanchito: October 7, 1948 (1♂, 1♀); in light globe, June 20 (1♀).

Scalenarthrus LeConte (1880, p. 185)

This is a small genus in the tribe Brachyglutini containing about twenty neotropical species. Six species were taken in Honduras, all agreeing as follows: 11-segmented antenna; body appearing glabrous, but covered with sparse, short, decumbent pubescence; posterior coxae widely separated; head (fig. 65) with three carinae, two lateral and one median, on the ventral side; pronotum distinctly punctulate, without foveae, but sometimes with a median, basal puncture; elytra without basal foveae, but each with four distinct basal punctures (except ***torrus*** n. sp.), plus two more punctures just anterior to the middle two basal punctures (except ***femoralis*** n. sp.); only the sutural stria visible; fourth sternite with carina near each lateral margin which extends the entire length of the sternite except in ***torrus***, ***inflatus*** Fletcher (1928, p. 210), and ***globosus*** Fletcher (1928, p. 209) where it occupies only the basal three-fourths; trochanter of the middle leg with the femur attached obliquely to it so that the coxa and the femur are approximate; fourth sternite with the two basal carinae (except ***torrus***) extending about one-third the length of the tergite and separated by the distance equal to one-fourth of the width of the tergite; middle coxae subcontiguous, the metasternum and mesosternum meeting truncately between them in a shallow depression.

KEY TO SPECIES

1. Antenna unmodified (figs. 63 and 64), ninth segment longer than wide, eleventh ovoid without any excavation near the base, but with an apical depression 2
   Antenna modified (figs. 61 and 62), ninth segment transverse, eleventh irregular in shape with a deep excavation at least near the base; males 6

2. Median carina on the ventral surface of the head not sharply defined and running over a blunt protuberance; antenna (fig. 63) with intermediate segments two to three times as long as broad; males and females... **olanchitus**
   Median carina (fig. 65) sharply defined and straight from a lateral view; antenna with intermediate segments nearly transverse..... 3
3. Metasternum concave, with a U-shaped depression between the middle and hind coxae; second segment of anterior tarsus broad and flattened; males, ... **depressus**
   Metasternum convex; second segment of the anterior tarsus unmodified, not flattened..... 4
4. Anterior femur modified (fig. 66), enlarged abruptly near the base; males, ... **femoralis**
   Anterior femur unmodified, not abruptly enlarged near the base..... 5
5. Fifth sternite with two large pits; eighth sternite with two small warts; males..... **torrus**
   All sternites unmodified; females..... **depressus**
6. Tenth antennal segment excavated (fig. 61), ninth much wider than long, eleventh mesally excavated, deeply on the basal one-half and shallowly on the apical half..... **inflatus**
   Tenth antennal segment not excavated (fig. 62), ninth only slightly wider than long, eleventh excavated on the base only..... **globosus**

Scalenarthrus depressus n. sp.

Male.—Length about 1.5 mm.; color light brown. Head quadrate; two vertexal foveae on the interocular line; slight depression between the antenna formed by the small antennal tubercles. Antenna (fig. 64) with 2nd segment ovate; 3rd elongate, widest at apex; 4th to 8th each slightly elongate, widest at apex; 9th as wide as long, widest at apex, distinctly wider than 8th; 10th transverse; 11th ovoidal, as long as the preceding four segments combined, with a median depression on the apical third. Pronotum wider than long, sides curved, widest at the apical third, with small median basal puncture. Elytra subequal to the length of the abdomen, sides curved, widest at the apical third. The fourth tergite with two basal carinae, each extending one-half the length of tergite and separated by a distance equal to one-fourth the width of tergite; fifth to seventh tergites each decreasing in length; pygidium bluntly rounded with a short transverse rounded laminoid projection near the apex, readily seen from the side. The fourth sternite longest; fifth to eighth each gradually decreasing in length. Metasternum with a shallow depression originating at the posterior coxae then evenly rounded and touching each of the middle coxae. The second segment of the anterior tarsus flattened, twice as broad as the last segment and covered with short stiff hairs on the ventral side. Basal piece of genitalia (fig. 68) conical; left and right lobes very similar, differing mainly in the shape of the small accessory lobes; ventral lobe cylindrical, upturned near the apex; median lobe short and characteristically shaped in all males as illustrated.

Female.—Differs from the male by having a convex metasternum, second segment of the anterior tarsus not flattened, similar to the middle and the posterior tarsus, and the pygidium without laminoid projection.

Holotype male.—Olanchito, June 21. *Allotype* female, same data as the holotype. *Paratypes*, 106 males, 49 females. Olanchito: October 7, 1948 (3♂, 4♀) in light globe, June 20 (52♂, 13♀), June 21 (25♂,

14 ♀), July 5 (1♂, 1♀), July 14 (1♀), July 29 (2♀), July 30 (3♂, 10♀), August 24 (1♂), September 7 (1♂, 2♀), September 8 (20♂, 2♀).

S. depressus is in group 1 of Park (1942, p. 167) and is most closely related to the West Indian *guadelupensis* Raffray (1912, p. 289). It is distinguished from *guadelupensis* by the smooth front, whereas the latter species has a minute median tubercle. The middle segments of the antenna are moniliform in *guadelupensis*, but they are slightly elongate in *depressus*.

Scalenarthrus femoralis n. sp.

Male.—Length about 1.5 mm.; color light brown. It is very similar to *depressus* in many respects, but differs strikingly in the following points. The labrum is slightly emarginate at the center of the apical edge. The 2nd segment of the antenna is cylindrical; 3rd elongate, widest at the apex; 4th to 8th segments each quadrate, slightly wider at apex than at base; 9th slightly transverse, widest at middle; 10th transverse, sides nearly parallel for the basal one-half and sloping inward on the apical half; 11th large, as long as preceding five combined, oval, more robust than in *depressus*, with slight depression on the apical mesal half. Pronotum as in *depressus*. Each elytron with only four minute basal punctures, without the two anterior ones as in the other species. Basal carinae of fourth tergite very minute and about one-half as long as those on *depressus*. Anterior femur (fig. 66) suddenly enlarged on the dorsal side about one-fourth the distance from the base; on the apical half of the dorsum of the femur, an elongate flat area bounded by a carina. The second segment of the anterior tarsus cylindrical and not flattened as in *depressus*. The genitalia (fig. 71) entirely different having a forked median lobe, forked basal piece, and without apparent left and right lobes.

Holotype male.—La Ceiba, August 26. *Paratype* male, Olanchito, September 8.

This species is a member of group 1 of Park (1942, p. 167) by virtue of the two very fine and short basal carinae on the fourth tergite. *S. femoralis* is definitely related to other *Scalenarthrus* considered in this report because of the presence of strong carinae on the ventral surface of the head, but the enlarged anterior femur and the different type of genitalia raise a question as to the correct generic placement of this species. Future students studying the phylogeny of this and related genera may find that consideration of the genitalia and other poorly evaluated characters may form a basis for generic reclassification in this section of the family.

Scalenarthrus olanchitus n. sp.

Male.—Length about 1.5 mm.; color light brown. Head nearly twice as long as wide; slight depression between the antennal bases; two small vertexal foveae just posterior to the interocular line; each mandible with a sharp tooth on the outer edge about half way between the base and apex; ventral surface of head with a blunt protuberance over which passes a poorly defined median longitudinal carina; the two lateral carinae faintly defined. Antenna (fig. 63) elongate, 3rd, 5th, 6th, 7th and 9th segments each about 2.5 times as long as wide,

widest at apex; 4th and 8th each twice as long as wide, widest at apex; 10th slightly longer than wide; 11th ovoidal, depressed near apex on inner surface, not quite as long as the preceding three segments combined. Pronotum quadrate, sides curved, widest at the apical third; no median basal puncture as in the other species; disc smoothy convex, apex and base slightly pinched mesally forming a short blunt ridge. Elytra subequal to length of abdomen; sides curved, widest at apical third. The fourth tergite with two basal carinae each extending one-fourth the length of tergite and separated by a distance equal to one-third the width of tergite; fifth to seventh each slightly shorter than preceding; pygidium with a short rounded point at apex. Underside of abdomen concave; fourth to seventh sternites each shorter than preceding at side margins, but very short mesally; eighth shorter than seventh at lateral margins, broadly depressed mesally, longer than fourth to seventh combined mesally. Metasternum with a depression between the posterior coxae which extends forward to a distance equal to one-half the length of the metasternum, this depression well marked, with a carina and thickly covered with short erect pubescence which is silvery in reflected light; mesosternal process between middle coxae very narrow, but truncate. The second segment of the anterior tarsus attached near the base of the first segment so that most of the first segment projects beneath the second. Left lobe of genitalia (fig. 70) simple, the right lobe divided near its base; basal piece elongate, about three times as long as wide; median lobe joined to basal piece and characteristically shaped in all males as illustrated.

Female.—Differs from the male in the following respects: mandible smooth, without sharp tooth on outer edge; pygidium evenly rounded at apex; fourth sternite is subequal in length to the eighth; fifth, sixth, and seventh sternites each progressively shorter; abdomen smoothly convex; metasternum convex; anterior tarsus with the second segment joined to apex of first.

Holotype male.—Olanchito, June 21. *Allotype* female, same data as holotype. *Paratypes*, 5 males, 8 females, Olanchito: June 20 (2♂, 2♀), June 21 (2♂, 4♀), July 6 (1♀), July 7 (1♂, 1♀).

This species belongs to group 1 of Park (1942, p. 167). The mesosternal process between the middle coxae is much narrower than in the other Honduras species of *Scalenarthrus*. If the coxae of this species are considered "subcontiguous" in Park's key (1942, p. 167), this species keys to the genus *Xybarida*. However, it does not fit the generic descriptions given by Raffray (1896a, p. 260; 1908, p. 217). The poorly defined median carina on the ventral surface of the head is strikingly different from the very distinct carinae of other species of *Scalenarthrus* examined, resembling more the slight ridge of *Reichenbachia*, but in the latter genus there are no lateral carinae. Also the head of *olanchitus* is longer than the other *Scalenarthrus* studied, the antennae are longer, much more slender, and the tooth on the mandible are characters similar to those of some *Reichenbachia*. There is no median pronotal puncture on *olanchitus* as in the other *Scalenarthrus*. The concave abdomen, prolonged first segment of the anterior tarsus, and the tooth on the mandible are secondary sexual characters not found in the other *Scalenarthrus* examined. However, on the basis of

the genitalia which is of the same general form as the other species, and because of the lack of representatives of more species of *Scalenarthrus* for comparison, it is thought best to include *olanchitus*, as well as *femoralis*, in this genus. *Scalenarthrus* is a very poorly defined genus and a critical study of the entire genus and related genera may reveal characters which might aid in the subdivision of *Scalenarthrus* into about three major groups of species, each possibly of generic rank.

Scalenarthrus torrus n. sp.

Male.—Length about 1.5 mm.; color light brown. Head elongate; two vertexal foveae on the interocular line. Antennae the same as for *depressus* (fig. 64). Pronotum subquadrate, sides curved, widest at apical third. Elytra subequal in length to abdomen; sides curved, widest at apical third; surface without what usually are called basal punctures, but with two punctures anterior to the usual location of the four basal punctures. The fourth tergite without basal carinae; fifth to seventh tergites each decreasing in length; eighth bluntly rounded. The fifth sternite with two hollow finger-like projections on the anterior edge each extending forward to a distance equal to one-half the length of the sternite; sixth and seventh sternites simple, each shorter than preceding; eighth with two wart-like projections separated by a distance equal to one-half the width of the sternite, each projection flat on top and constricted posteriorly at the base; interiorly with two large flat plate-like projections extending forward to the base of the fifth sternite, each spreading from lateral margin nearly to the median line. Metasternum slightly convex. Basal piece of genitalia (fig. 72) with simple lateral lobes solidly joined; ventral lobe L-shaped; median lobe with small flat projection on dorsal side near base.

Holotype male.—La Ceiba, August 26.

Apparently this species is not closely related to any of the other species in group 2 of Park (1942, p. 167) to which it keys. This species is readily distinguished from all other known *Scalenarthrus* by having pits and warts on the sternites as described above. All others have smooth sternites.

Scalenarthrus inflatus Fletcher

Scalenarthrus inflatus Fletcher (1928, p. 210).

This species belongs to group 4 of Park (1942, p. 167). It may be readily distinguished from other Honduras species by the odd antenna (fig. 61). Segments 8 to 11 form a distinct club; 9th wider than long; 10th excavated on the inner surface; 11th deeply excavated on the basal half of the inner surface and shallowly excavated on the apical half. On the basal edge of the deep excavation there is a tuft of hairs which are closely appressed so as to appear as a chitinous projection. The metasternum is evenly convex. The genitalia (fig. 69) are very similar to those of *globosus* Fletcher (fig. 67), differing, however, in the shape of the left and right lobes and in the length of the median lobe which is much shorter than that of *globosus*.

Distribution. This species was described from Vera Cruz, Mexico, and was recorded later from Guatemala by Park (1945, p. 404). La

Ceiba: May 21 (1♂), May 27 (1♂), May 29 (1♂), August 28 (1♂). Olanchito: June 21 (1♂), August 24 (1♂), September 8 (2♂).

Scalenarthrus globosus Fletcher

Scalenarthrus globosus Fletcher (1928, p. 209).

This species is in group 4 of Park (1942, p. 167), and differs from the other species by the form of the antenna (fig. 62). Segments 8 to 11 form a distinct club; 9th slightly wider than long; 10th transverse, with a projection on the inner surface which overlaps the base of the 11th and terminates with three or four long setae; 11th oblong, with a deep excavation on the basal half of the inner surface, this excavation having a small projection originating from the basal edge and terminating with several short setae. The metasternum has a very slight depression between the posterior coxae which extends forward to a point about one-third the length of the metasternum. The genitalia (fig. 67) have a conical basal piece with the left and right lobes dissimilar, ventral lobe freely articulated with the basal piece, and median lobe long and characteristically shaped in all males as illustrated.

Distribution. This species was described from Guatemala and British Honduras and has been recorded from Mexico by Park (1945, p. 403). La Ceiba: August 26 (6♂), August 28 (1♂). Olanchito: June 20 (2♂), July 14 (1♂).

ENTOMOLOGIA AGRICOLA DEL PERU, by JOHANNES E. WILLE. Second Edition. Pp. viii+544, 221 figs. La Junta de Sanidad Vegetal, Dirección General de Agricultura, Lima, Peru. 1952.

The second edition, revised and enlarged, of a work first published in 1943, attempts to bring up to date this important Spanish language text, chiefly through a revision of the relative importance given to various insects pests, a reconsideration of control recommendations in respect to the new insecticides, and the addition of ecological and biological information pertinent to economic insects and their control. The text deals entirely with pests of agricultural crops, ornamentals, and stored products, the medical and veterinary aspects being omitted; biological control, however, is included. A glossary is added which, though brief, will be of aid to the English-speaking student by helping him to acquire the Spanish equivalents.

The book is well printed on a good grade of paper. Most of the illustrations are satisfactory, though some of the half-tones reproduced poorly.—M. T. J.

BOOK NOTICES

ENDOSYMBIOSE DER TIERE MIT PFLANZLICHEN MIKROORGANISMEN, by PAUL BUCHNER. Pp. 771, 336 figs, 3 plates. E. Birkhäuser & Cie, Basel. 1953. Price, SFr. 66.50 (bound).

The work of Prof. Paul Buchner and his school on the phenomenon of endosymbiosis in animals is not as well known nor as fully appreciated by biologists (especially entomologists) in this country as it deserves. This is true in spite of the fact that Buchner, and his students, have published copiously (mostly in German) on their remarkable observations. In 1930, Buchner published his "Tier und Pflanze in Symbiose" which served as a comprehensive treatment of the subject as it was known up to that time. The present volume is, in a sense, a new edition of this earlier work, but it has been completely rewritten, restyled, and encompasses a more profound treatment of the fundamental problems involved.

Although endosymbiosis in animals other than arthropods is included in the book's scope, the greater part of the volume has to do with symbiosis in insects. The tissue cells of many normal insects and ticks harbor specific living microorganisms known as "symbionts" or, better, "symbiotes." These symbiote-containing tissues are frequently organized into special organs known as "mycetomes." Specific symbiotes are also known to occur regularly in the alimentary tracts and in the lumen of special crypts or caeca of certain insects. The microorganisms concerned are usually bacterial, rickettsial, or yeastlike in nature and most of them remain to be cultivated and studied from a microbiological point of view. In some instances it is known that the symbiotes produce vitamins or other growth-promoting substances; in other insects it is believed that the intracellular microorganisms fix atmospheric nitrogen as required by the host. Other possible "functions" of the symbiotes no doubt exist. In any case, the insect-symbiote relationship is an intimate one since in most instances every individual of an insect species harbors the symbiote or symbiotes specific for that species. The symbiotes are transmitted from one generation of the insect to the next by any of a great variety of methods, most of them rather exacting and complex. All of these relationships, and more, are discussed by Buchner in his book. It is the most extensive treatment of the subject to appear in any language; the present volume is written in German but it is hoped that an English translation will eventually appear.

The book is divided into sections that include the discussion of such subjects as: historical considerations, errors in symbiosis research, algae-symbiosis, symbioses in animals that live on cellulose-rich substances, leafy plants, seeds, and similar nutrients, symbiosis in animals that live in plant exudates, symbiosis in animals that suck plant juices, symbiosis in animals that suck vertebrate blood and consume keratin, symbiosis in insects that live on mixed diets, symbiosis in luminescent animals, symbiosis localized in organs of excretion, the habitats of symbiotes, the methods of symbiote-transmission, the embryological and post-embryological occurrence of symbiotes, the relationships between the host organism and its symbiotes, phylogenetic relationships, and the biological significance of symbiosis. An excellent bibliography and indices to authors and to plant and animal names enhance the usefulness of the book.

The book is a large one, covering all pertinent literature on the subject, but it is not given to verboseness. It is well written and particularly well illustrated. It is accurate, scholarly, usually very thorough, authoritative, and carefully critical. The printing and binding are of top quality. The book is truly a highly significant and extremely valuable contribution to the field of endosymbiosis, and should prove to be an invaluable reference work for entomologists (especially insect physiologists, morphologists, ecologists, and microbiologists) and for biologists generally.—E. A. STEINHAUS.

LIMNOLOGY, by PAUL S. WELCH. Second Edition. Pp. xii+538, 50 figs. McGraw-Hill Book Co., New York. 1952. Price $8.00.

The second edition of this well-known text is a thorough revision, with most of the material of the first edition retained, but with the incorporation of many new developments resulting in a much larger book.—M. T. J.

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